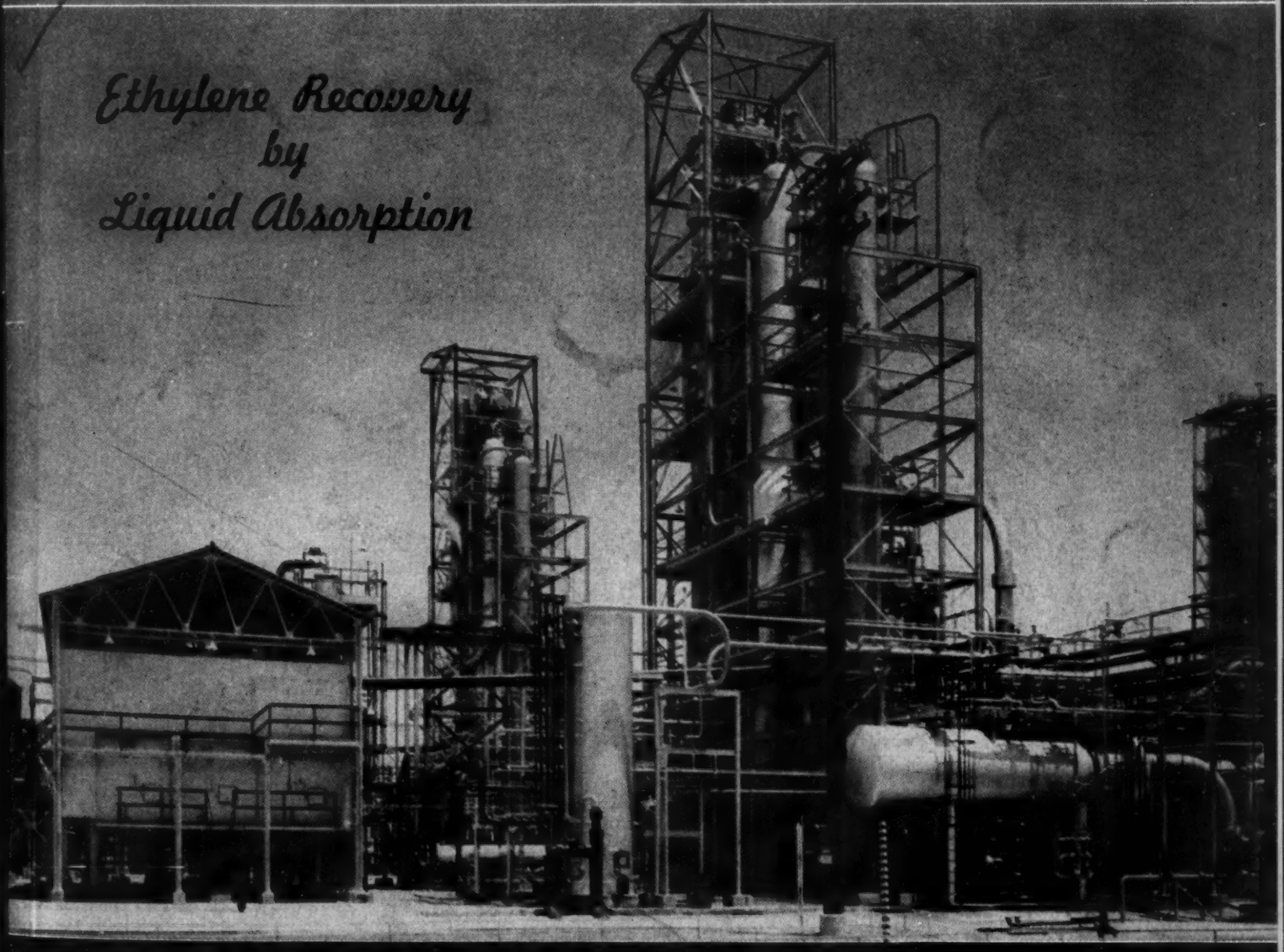
PETROLEUM PROCESSING

VOLUME 2, NUMBER 10 OCTOBER, 1947

Ethylene Recovery by Liquid Absorption



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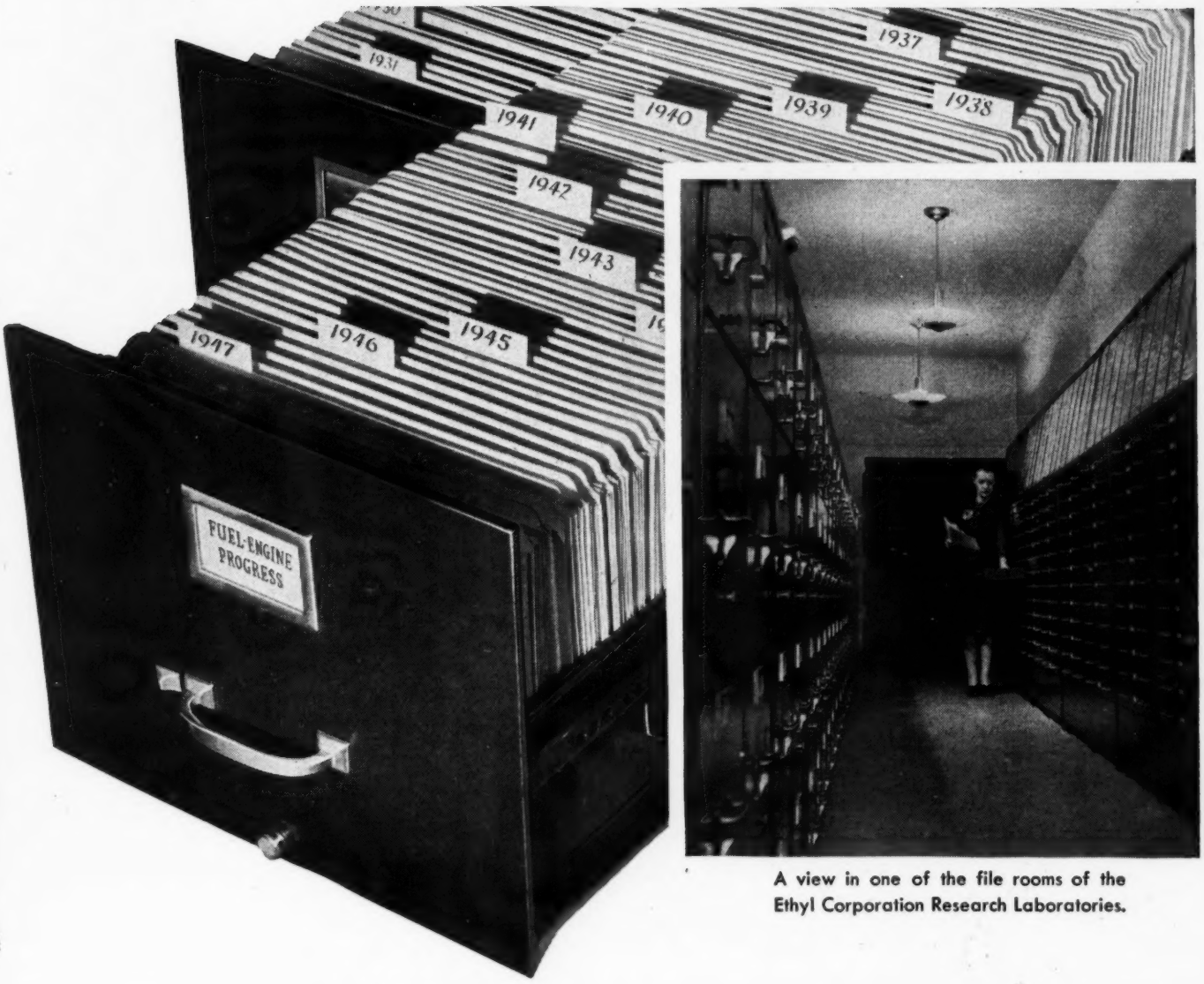

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VOLUME 2
NUMBER 10
OCTOBER, 1947
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PETROLEUM PROCESSING

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for October, 1947

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COVER STORY

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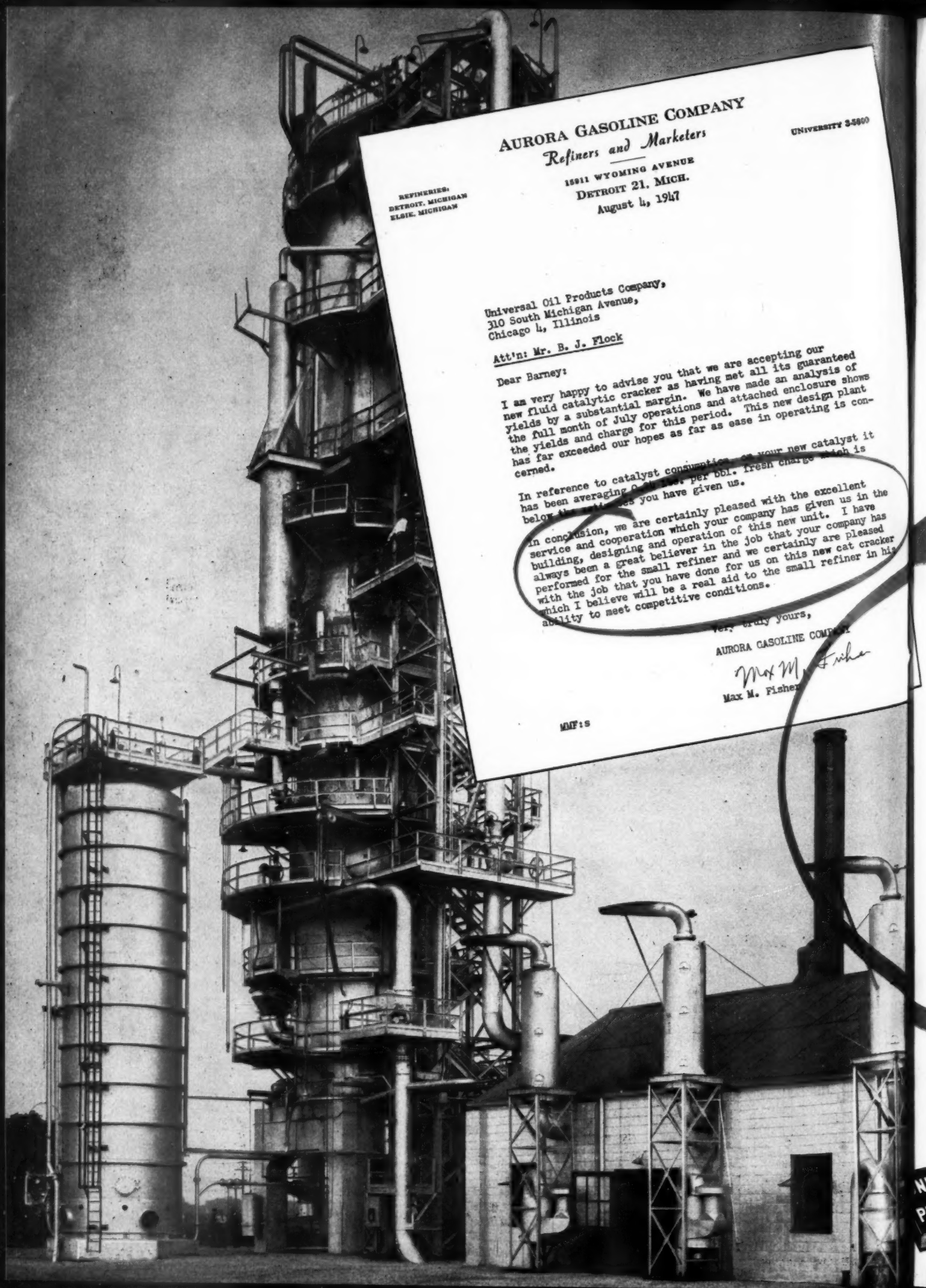

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August 4, 1947

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Att'n: Mr. B. J. Flock

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In reference to catalyst consumption of your new catalyst it has been averaging [illegible] per bbl. fresh charge which is below the estimates you have given us.

In conclusion, we are certainly pleased with the excellent service and cooperation which your company has given us in the building, designing and operation of this new unit. I have always been a great believer in the job that your company has performed for the small refiner and we certainly are pleased with the job that you have done for us on this new cat cracker which I believe will be a real aid to the small refiner in his ability to meet competitive conditions.

Very truly yours,

AURORA GASOLINE COMPANY

Max M. Fisher

Max M. Fisher

MMF:s

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What's Happening!

OCTOBER 1
1947

Summary of Current News Developments Concerning Oil Men

HIGHLIGHTS *Emphasis in plant construction continues on light oil units, gasoline and cycling plants. Other oil company projects are being laid aside temporarily to expedite completion of new facilities to supply standard products now in such great demand . . . Research laboratory expansions, however, are announced by two companies. . . . Two surplus avgas plants have been disposed of by WAA under the stipulation the new operators give preference to supplies for the military. . . . Demand of European nations for petroleum products under Marshall plan has been estimated at Paris conference as reaching 1,400,000 b/d by 1951. U. S. authorities feel this figure should be scaled down, for one thing to bring about greater use of Europe's abundant fuel resource—coal.*

Refinery Building Bay Petroleum Co., Denver, installing thermal reforming and catalytic polymerization units at its Denver refinery, and thermal reforming unit at McPherson, Kans. Universal Oil Products designed the units; construction at Denver by the oil company's force, at McPherson by Refinery Engineering, Chicago. . . . Construction to resume on new 20,000 b/d refinery of Carter Oil Co. at Billings, Mont., on which work stopped two months ago because of rising building costs, because of product demand in this area. . . .

Standard of Ohio has contracted with Universal Oil Products for design of 16,000 b/d Fluid "cat cracker" and gas recovery system to be installed in its Lima, Ohio, refinery. Arthur G. McKee & Co., Cleveland, are general contractors. Work is part of $10,000,000 refinery expansion program announced earlier. . . . Figures on its expansion program for 1947 issued by Standard Oil Co. (N. J.) show $50,000,000 is being spent in modernizing the Bayway, Baltimore, Baton Rouge and Charleston, S. C., refineries and $5,000,000 by Humble in enlarging its Baytown refinery. Jersey's affiliates are putting over $140,000,000 into new facilities at Fawley, in southern England. Charging capacity there will be 120,000 b/d by 1952, with crude coming from the Middle East fields. . . .

Ashland Oil & Refining Co. to construct a products terminal on a 30-acre site at Clarksville, Ind., opposite Louisville. . . . Waterway Terminals Inc., owned jointly by Cities Service Oil Co., Western Oil & Fuel Co., and Petroleum Heat and Power Co., will build $750,000 products terminal on Chicago Sanitary District Canal, capacity 460,000 bbls. . . .

New Cycling and Gasoline Plants The big Katy cycling plant near Houston, now processing 450,000,000 cu. ft. of gas daily, will double its capacity for producing ethane, propane and butane, at cost of $3,860,000, work to be done by Stearns-Roger Mfg. Co. Humble operates the plant under cooperative arrangement with other gas producers. . . . American Republics Corp. and Houston Oil Co. will build a $3,000,000 natural gasoline plant in the Silsbee field, in Hardin county, Texas. Gasoline Plant Construction Co., Houston, Tex., in the contractor. . . .

Richardson & Bass, Fort Worth, with Phillips Petroleum and Sinclair-Prairie, will build natural gasoline plant in Winkler county, Texas, to process 55,000,000 cu. ft. of gas daily. Jones & Laughlin Supply Co., designers. Richardson & Bass will operate the plant. . . . Construction started on $2,000,000 cycling plant in Montgomery county, Texas, by Gray-Wolfe Co., Houston. O. L. Olsen, Houston, is contractor. . . .

Construction started on natural gas processing plant, capacity 100,000,000 cu. ft. daily, near Hooker, in Oklahoma Panhandle, for Harrington & Marsh, Amarillo, Texas. Contracting engineers, J. F. Pritchard & Co. . . .

New Research Facilities Pittsburgh Consolidation Coal Co. has awarded to Blaw-Knox contract for design and construction of its experimental coal gasification plant near Pittsburgh, to cost $500,000. Plant is joint project of the coal company and Standard Oil Development Co., to develop commercial process for making synthesis gas from coal. . . . Cities Service Oil Co. to build new technical service laboratory at East Chicago refinery. . . . The Texas Co. is erecting new building at its Beacon, N. Y. research laboratories to house latest gas turbine and jet propulsion equipment.

War Plant Disposals In its first disposal of a surplus avgas plant under the policy of giving "preferential consideration" to bidders who guarantee the armed forces will have first call on products, WAA accepted the $3,250,000 offer of Petrol Terminals Corp., Philadelphia, for the Texas City plant operated during the war by Southport Petroleum Co. Plant originally cost $11,543,000. . . . Ashland Oil & Refining Co. was only bidder on the Catlettsburg, Ky., surplus avgas plant, with bid of $2,153,125, based on

minimum throughput of 7500 b/d for 5 years.

Original cost was $16,500,000. . . . Surplus carbon black plant at Odessa, Texas, sold by WAA to Sid. W. Richardson, Fort Worth oil and gas operator, for $4,300,000. Plant, operated during war by United Carbon, Inc., cost $9,500,000. . . .

Government-owned aviation gasoline plant at Richmond, Cal., has been sold by WAA to Standard of California for $6,000,000. Construction cost was $21,348,000. The plant, located on land owned by purchaser but leased to government, includes two TCC units with separate gas conversion plants and HF alkylation, isomerization, butane-pentane and distillation units, together with utility and auxiliary facilities.

Washington Army, through Fuels and Lubricants Branch, OQMG, has raised its requirements in U. S. for 2-102C Diesel fuel over balance of current fiscal year by 1,500,000 bbls., through failure to secure this amount from Persian Gulf for needs in Europe. It will attempt now to raise entire requirement, 2,500,000 bbls. on Gulf and East coasts. . . . Average octane number of regular gasoline sold in U. S. the winter of 1946-47 was 75 ASTM and of premium 78.5, the U. S. Bureau of Mines semiannual survey showed. This compares with 74.4 average for regular and 78.3 for premium the summer of '46. . . .

Petrochemicals The phthalic anhydride plant of Oronite Chemical Co., subsidiary of Standard of California, at Richmond, is to double its capacity. The increased output will be available the first half of 1948. . . . A new treatment which makes possible the use of polystyrene for surfaces where marring or other conditions heretofore have required more expensive plastic materials will greatly increase the field of use of styrene resins, it is believed. The treatment, called "Logoquant", was developed in the Bjorksten Research Laboratories, Chicago, at the behest of Nash-Kelvinator Corp.

Foreign Oil The 16 nations conferring at Paris under the Marshall plan, through a technical petroleum subcommittee of the Committee of European Economic Cooperation, have estimated their total petroleum requirements in 1951—last year of the Marshall plan—at about 1,400,000 b/d. This is more than double actual deliveries to these countries in either prewar 1938 or postwar 1946. U. S. authorities will insist that these estimates be scaled down to force greater utilization of the most plentiful fuel resource in Europe—coal.

. . . When the British Petroleum Board, through which supplies in Britain have been pooled for the past 8 years, is abolished Dec. 31, an advisory consumers' council will be set up, the Minister of Fuel and Power has announced. Critics of this proposal point out that in the critical times ahead technical advice from the oil companies will be needed by the government, rather than recommendations from consumer representatives.

Work to start at once on 24,500 b/d Fluid "cat cracker" at Abadan, Iran, for Anglo-Iranian Oil Co., Ltd. Foster Wheeler Corp. is design and construction engineer. Anglo-Iranian also to build 400 b/d, furfural solvent refining, MEK dewaxing and clay contacting plant at Abadan. . . . Mediterranean terminal of the 1030-mile Trans-Arabian pipeline is to be near Sidon, 30 miles south of Beirut, Lebanon. Convention for transit rights was signed with the Syrian government by Trans-Arabian Pipe Line Co. Sept. 1. The new line, scheduled for completion late in 1949, will make 300,000 b/d of crude available to Europe.

J. Edward Jones, independent producer president of Sugar Field Oil Co., Baton Rouge, awarded contract to drill first 100 out of minimum of 200 wells in Mexican government's new exploration program. Contract calls for issuance to Jones by Mexican government of 5-year, 6% bonds to cover cost of operations plus 10%. Jones in turn will seek authority from SEC to float bond issue in this country for $20,000,000 to cover estimated cost of the well drilling project. Payment to the contractor by Petroleos Mexicanos, will be in oil on basis of 35% of new wells production with option to buy additional 15%. . . .

Top Names in the News T. G. Delbridge retired Oct. 1 as manager of Atlantic Refining's Research and Development Dept. He joined Atlantic as a works chemist in 1909. H. W. Field, now assistant manager, will succeed him. . . . L. G. Smith elected vice president in charge of refining for Creole Petroleum Corp., of Standard Oil Co. (N. J.) interests. . . . J. B. Fisher, president Kendall Refining Co., Kendall, Pa., reelected president National Petroleum Assn. . . .

P. C. Spencer is new president Sinclair Refining Co., to succeed H. F. Sinclair who resigned this position. He began his oil career in 1922 with Producers and Refiners Corp., later acquired by Sinclair interests. . . . E. R. Turner, first vice president and general manager of Pan American Companies, Houston, elected president of Pan American Production Co., Pan American Pipe Line Co., and Pan American Gas Co., succeeding D. J. Smith, who was recently elected president of the parent Pan American Petroleum & Transport Co. . . . R. W. McDowell, Tulsa, vice president for marketing, Mid-Continent Petroleum Corp., has been elected executive vice president. . . .

Named to membership on the National Petroleum Council by Interior Secretary Krug are Bruce K. Brown, president of Pan American Petroleum Corp.; Ardon B. Judd, vice president and general manager Republic Supply Co., Houston, and president Petroleum Equipment Suppliers Assn.; Alexander Fraser, president Shell Union Oil Co., and Russel S. Williams, president, Individually Branded Petroleum Assn. of America. . . .

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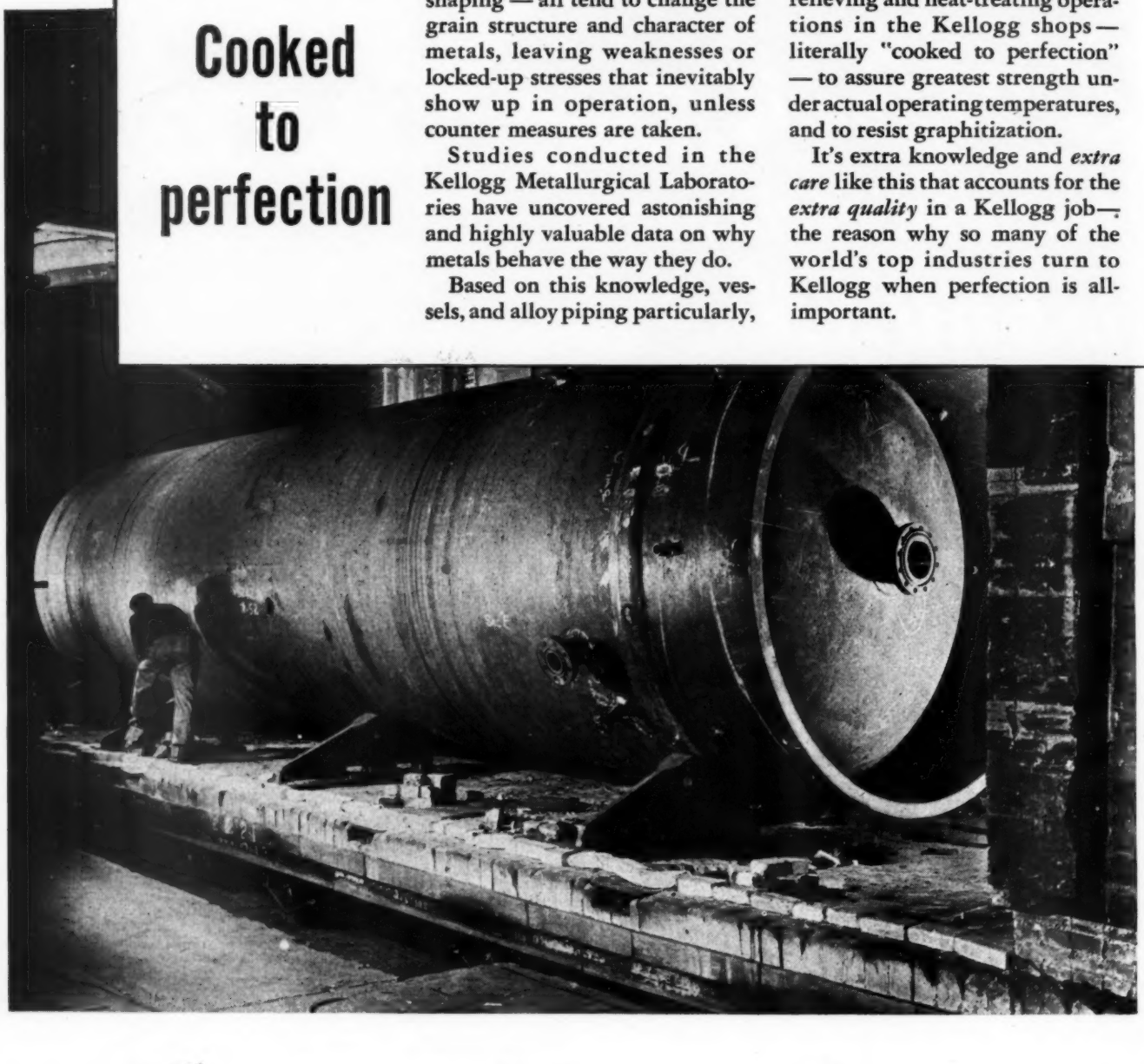

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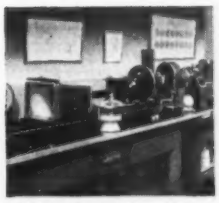

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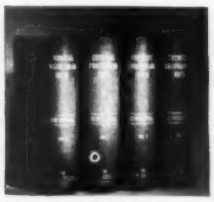

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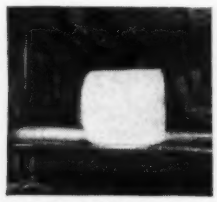

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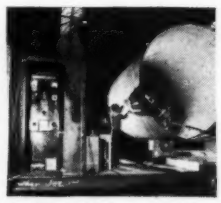

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PETROLEUM PROCESSING
OCTOBER, 1947

SYNTHESIS GAS FROM SOLID FUELS

Research Work to Develop Low-Cost Means for Gasifying Coal, as First Step Towards the Manufacture of Synthetic Gasoline and Other Products from Solid Fuels, Is Already Well Advanced, the Nation's Chemists Are Told

By WILLIAM F. BLAND
Engineering Editor

WITHIN the decade, this country will be producing low-cost synthetic gasoline and oil in part at least from solid fuels and on a scale which will dwarf the wartime German synthetic fuels project, which at its peak was providing the Nazi war machine with over a quarter of its fuel needs.

Such is the opinion of Dr. A. R. Powell, Associate Director of Research for Koppers Co., Pittsburgh, expressed as he opened a symposium on "Production of Synthesis Gas", held as part of the program of the 112th national meeting of the American Chemical Society, in New York, Sept. 15-19. The symposium was sponsored jointly by the society's Division of Petroleum Chemistry and Division of Gas and Fuel Chemistry.

In his introductory remarks Dr. Powell, chairman of the symposium, declared, "it now appears likely that the synthesis of liquid fuels will prove to be one of the major technical developments in this country during the next decade."

Probably the most difficult and also the most important problem connected with the synthetic liquid fuels program, according to Dr. Powell, is the production of low-cost synthesis gas (hydrogen and carbon monoxide) from natural gas and cheap grades of coal. Beside serving as the primary raw material for Fischer-Tropsch type reactions for making synthetic fuels, synthesis gas may also serve as the source of hydrogen needed to convert coal to liquid fuel by the Bergius coal hydrogenation process.

"Therefore, irrespective of the type of process used, synthesis gas is essential, and it must be produced cheaply in order to make liquid fuels at a cost not too far in excess of present costs of making gasoline and fuel oils from natural petroleum," Dr. Powell pointed out.

Among the new and improved methods described at the symposium for the manufacture of synthesis gas were:

1) A new entrained powder process for making synthesis gas directly from pulverized coal, without the intermediate formation of coke, and employing pure oxygen.

2) A process for reacting light hydrocarbons (methane-propane) with steam and carbon dioxide to produce a synthesis gas of the desired ratio.

3) The conversion of low-grade coal and lignite directly into synthesis gas in a continuous stream without the use of pure oxygen, but employing alloy retorts which permit higher operating temperatures.

4) The oxygen gasification of solid fuels, anthracite and coke, in a fixed-bed gas producer.

Research Guided by German Efforts

American scientists and engineers are being guided in their research on this subject by the work done in Germany, where the synthetic fuel industry supplied the Nazi war machine with 29% of its liquid fuel requirements at the peak of the war.

This figure of 29% sounds impressive at first glance, until one realizes that it was equivalent to less than 2% of the American wartime crude oil production, according to Dr. Powell. "In other words," he said, "if we in America ever have the necessity of producing synthetic liquid fuel in a volume equivalent to our recent wartime production of crude oil, we will require a capacity over 50 times that of this relatively huge industry of the Germans."

The Germans used blue water-gas as their raw material for the Fischer-Tropsch reaction. It is made by blowing steam over glowing coke, he explained, pointing out that while blue water-gas is a satisfactory material and is produced in quantity in America, it is too expensive to be practical for the economical production of synthetic liquid fuels.

Even if blue water-gas were used, current American production would have to be expanded a hundredfold to furnish the fifty trillion cubic feet of synthesis gas that would be required annually to supply this country with liquid fuel, according to Dr. Powell.

Vital factors in minimizing the cost of synthetic gasoline in this country, he asserted, will be the magnitude of the synthesis gas industry and the use of natural gas as the cheapest raw material known today. The great quantities of gas required will make necessary the erection of very large plants, which in themselves will insure the lowest possible unit investment cost and the greatest operating economies. The two commercial plants now projected (at Brownsville, Texas, and in the Hugoton field of Southwestern Kansas) will synthesize from natural gas to make fuels, chemicals and other products.

Cheap grades of coal and coal that is burned right in the mine merit further investigation as economical sources of synthesis gas, Dr. Powell said.

"Most important of all in securing lower costs will be the research and development efforts that are even now well under way and will swell to a crescendo within the next few years," he predicted.

"Chemists and engineers with a background of experience in petroleum technology and those with a background in coal and manufactured gas technology are today tackling this problem. The coal industry and the petroleum industry find here a common meeting ground, and some of the present programs are being, and surely more of the future research programs on synthesis gas will be, carried out co-operatively by the two groups."

Most ambitious of these co-operative research projects is that of Jersey Standard and Pittsburgh-Consolidation Coal Co., for which a $500,000 research laboratory is now being built near Pittsburgh.

Brief reviews of the more important papers given at the symposium follow:

Pulverized Fuel Process

"Pulverized Fuel Process for Synthesis Gas Experimental Unit Operating on Entrained Powder," by P. W. Edeburn, L. D. Schmidt, J. P. McGee and F. Bonar, U. S. Bureau of Mines, Synthesis Gas Production Laboratory, Morgantown, W. Va.

This paper describes an experimental unit designed and fabricated at the Bureau of Mines Synthesis Gas Production Laboratory in Morgantown, W. Va., for the purpose of obtaining data necessary for the design and construction of a large-scale unit to develop a new entrained powder process for making synthesis gas from pulverized fuel. The work was also concerned with testing cokes, chars, and coals from various sources for their synthesis gas-making properties, but that portion of the paper is not included in this review.

The authors define a pulverized or powdered fuel as "coke or coal that has been reduced to small particles or powder, of which 98% passes through a 50-mesh screen and 71% through a 200-mesh screen."

The apparatus developed, shown diagrammatically in the flow sheet Fig. 1, includes the generator and purification train which comprises the downcomer and sludge collector (1st scrubber), a second scrubber, and condenser, together with auxiliary feeding and control equipment.

The reaction chamber of the generator, shown in detail in Fig. 2, is a 3-in. silicon carbide tube 4 ft. long, with a 7/16-in. wall, through which the reacting materials and flames for heating pass downward. This tube is inside a concentric 6-in. tube of the same material, which extends 6 in. below the lower end of the inner tube. The outer jacket of the generator is made of a steel cylinder 24 in. in diameter, with the space between it and the silicon carbide tube filled with insulating brick. The gases pass downward through the inner tube and then upward through the annular space and out through a carborundum tube to the downcomer.

At the opening in the bottom of the generator is a 4-in. iron tube extending into a catch basin. This has a float valve at the lower end, which seals the tube to prevent water from rising up the tube in the case of a vacuum in the generator. This also acts as a pressure release in the event of an explosion in the system.

Atop the generator is the burner section, a 4-in. steel cylinder, 12 in. long, which is water-jacketed on the sides. It is attached to the generator and cover plate by flanges and bolts. Four ports for the burners enter through the sides at an angle so as to direct the flames down inside the inner reaction tube.

Powdered fuel is fed to the burner by means of an electrical vibrator from a hopper through a 1-in. connection. Carbon dioxide is admitted to the coal hopper through a pressure-equalizing tube, which joins the top of the hopper to the bottom of the feeder. The carbon dioxide is used to prevent oxygen from entering the feeder and hopper and reacting with the powdered fuel before it enters the generator.

Steam may enter the burner section from the superheater, or oxygen may be bubbled through water in the steam-oxygen ratio proportioner. The ratio of steam to oxygen can be controlled by the pressure and the temperature of the water in the proportioner. Steam may be admitted at the top of the burner section to purge the system.

Gases from the generator enter a downcomer and sludge collector (the first scrubber shown in Fig. 1), which is 10 in. in diameter and 4 ft.-2 in. long, with a spray ring at the top. At the bottom is a 2-in. pipe extending down into a catch basin, which acts as a water seal and explosion pressure release.

The gases next enter a second scrubber 6 in. inside diameter and 4 ft.-1 in. long, which contains a column of Raschig rings. The rising gases meet a spray of water from a spray ring near the top of the scrubber. The water passes out from the bottom through a 2-in. pipe into a catch basin, which forms another water seal and explosion pressure release.

The gases then enter the last stage in the purification train, which is a condenser 5 in. inside diameter and 26-¾ in. long where excess moisture is condensed out before the gases pass through meters either to storage or exhaust stacks.

No conclusions as to the future possibilities of the process or its economics were presented by the authors.

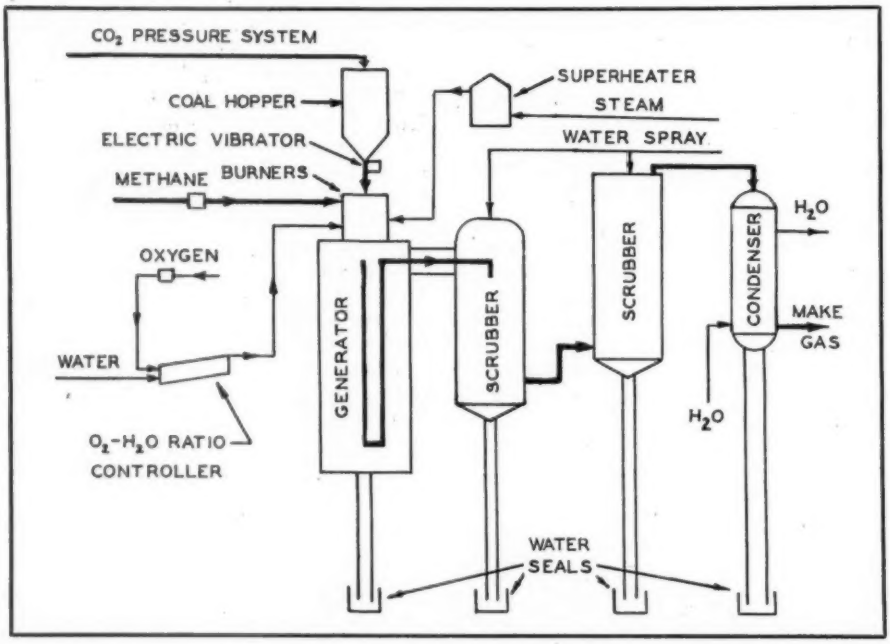

Fig. 1—Diagrammatic flow chart of U. S. Bureau of Mines experimental process for converting pulverized coal directly to synthesis gas, utilizing oxygen

Reacting Light Hydrocarbons

"Production of Synthesis Gas by Reacting Light Hydrocarbons with Steam and Carbon Dioxide," by R. E. Reitmeier, K. Atwood, H. A. Bennett, Jr., and H. M. Baugh, the Girdler Corp., Louisville, Ky.

As a result of work in the production of hydrogen from methane and its homologs, the Girdler Corp. has followed the development of the synthetic fuels program with more than normal interest. It is evident that the process used for the manufacture of hydrogen from light hydrocarbons, with slight modification, offers a practical means for producing hydrogen and carbon monoxide in the desired ratio for the synthesis reaction.

The first step in the process normally employed for producing hydrogen consists in reacting a hydrocarbon with steam over a catalytic material in a furnace at a relatively high temperature to form a mixture of hydrogen, carbon monoxide and carbon dioxide. The amounts of carbon monoxide and carbon dioxide present in the reaction products at this point in the process depend on the temperature of operation and the concentration of steam.

A second step consists of the catalytic conversion of the carbon monoxide to produce more hydrogen and carbon dioxide by means of the water-gas shift reaction, followed by the removal of the carbon dioxide by the Girbotol Process. It is obvious, however, that if the carbon dioxide were removed from the gas mixture from the first step of the process without subsequent treatment, there would be left a mixture consisting of carbon monoxide and hydrogen having

a composition similar to that used in the Fischer-Tropsch reaction for the production of liquid fuel.

The synthesis gas required in the Fischer-Tropsch reaction normally must have a hydrogen to carbon monoxide ratio of approximately 2, although special reacting conditions sometimes make it desirable to vary this ratio between the limits of 0.5 to 3. The usual reaction between light hydrocarbons and steam produces a gas mixture having a hydrogen to carbon monoxide ratio in excess of 3, and to make a synthesis gas with a lower hydrogen to carbon monoxide ratio, it is necessary to increase the concentration of carbon monoxide. This is readily accomplished by adding carbon dioxide to the reactants entering the reaction zone of the synthesis gas production plant.

It is recognized that the major possible difficulty encountered in reacting a light hydrocarbon with steam to produce hydrogen is the deposition of carbon on the catalyst resulting in an interruption of the process. Although conditions have been determined for the reaction of light hydrocarbons with steam alone without the deposition of carbon, the conditions necessary to prevent the deposition of carbon when light hydrocarbons are reacted with steam and carbon dioxide, to the author's knowledge, had not been established previously.

A study, therefore, was made to establish the optimum conditions for the production of synthesis gas mixtures having a ratio of hydrogen to carbon monoxide which could be varied between 0.5 and 3 in the same equipment without encountering difficulties as a result of the deposition of carbon, by controlling the temperature and the composition of the reactants.

Curves and formulae were developed to allow the selection of operating temperatures and reacting mixtures of light hydrocarbons, steam and carbon dioxide which would yield any desired synthesis gas mixture without carbon deposition.

Synthesis gas mixtures with hydrogen to carbon monoxide ratios between 0.5 and 2.0 were produced in the laboratory from methane, steam and carbon dioxide. Agreement between the compositions obtained and those predicted by the curves was good, and no carbon deposition was encountered when conditions were selected such that no carbon should have been produced.

In the production of synthesis gas mixtures from propane, steam, and carbon dioxide on a laboratory scale the predicted hydrogen to carbon monoxide ratios were obtained, although some carbon was produced from gas mixtures

In pilot plant work under practical operating conditions, synthesis gas mixtures with hydrogen to carbon monoxide ratios of 0.5, 1, and 2 were produced from propane, steam, and carbon dioxide without deposition of carbon. The compositions obtained were very close to the theoretical and the practicability of continuous operation was demonstrated by the fact that the individual runs were of six days duration.

Since it has been recognized that propane is more susceptible to carbon deposition than is methane, the satisfactory production of synthesis gas in the pilot plant from propane appeared to demonstrate rather conclusively that no difficulty would be encountered in producing synthesis gas on a commercial scale.

Gasification Without Oxygen

"Gasification of Sub-Bituminous Coal and Lignite in Externally Heated Retorts," by V. F. Parry, E. O. Wagner, A. W. Koth, and J. G. Goodman, U. S. Bureau of Mines.

During the war the Bureau of Mines conducted experimental work on two pilot plants for gasification of low-rank fuels to produce industrial gases for beneficiation of low-grade iron ores. The experimental data resulting from operation of the externally heated alloy retorts for a total of 3500 hours are summarized in the paper, and the fundamental theories of gasification and heat transfer are discussed. The theory of the annular retort and mechanism of gasification therein are presented. It is shown that synthesis gas ($CO + H_2$) can be made at rates of 65 to 70 cu. ft./hr./sq. ft. of heated surface in retorts heated to 1900° F.

The performance of various processes for producing synthesis gas in compared on the basis of cu. ft./hr./sq. ft. of fuel bed area. The Lurgi and Winkler generators, respectively, make 1000 and 8600 cu. ft. of synthesis gas per sq. ft., while externally heated processes make 1000 to 2300 cu. ft. Various grades of water gas having H_2 : CO ratios ranging from 1.9 to 10 were made in the pilot plants, but it is indicated that lowest cost gases and highest efficiency and capacity are attained when making gases of 2.0 to 2.5 H_2 : CO ratio.

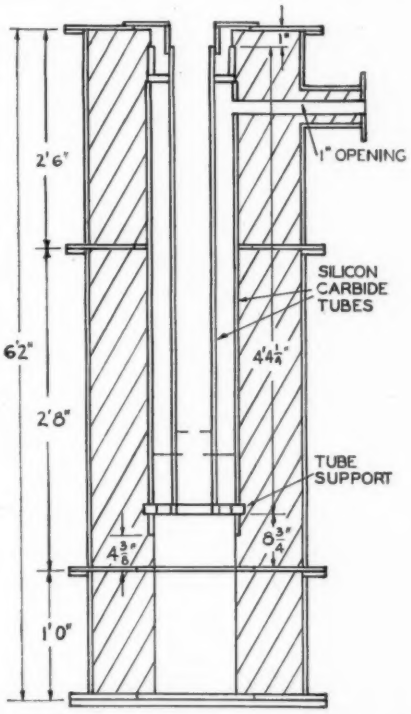

Fig. 2—Details of generator indicated in Fig. 1, showing concentric tubes which form reaction chamber

In considering the economics of externally heated retorts, it is shown that the cost of alloy is about one cent per 1000 cu. ft. of synthesis gas, assuming that a 0.25-in. thick alloy plate will have an average life of 10,000 hrs. at 1900° F. It is therefore indicated, that when making synthesis gas at a rate of 70 cu. ft./hr./sq. ft. in the externally heated retort, the equivalent cost of oxygen to make the same gas in an internally heated process would be 3 to 5 cents per 1000 cu. ft.

Gasifying Solid Fuels

"The Production of Hydrogen and Synthesis Gas by the Oxygen Gasification of Solid Fuels," by C. C. Wright, Pennsylvania State College, and R. F. Mitchell, Consolidated Mining & Smelting Co. of Canada.

Current interest in America with respect to the manufacture of synthesis gas from solid fuels, this paper points out, is centered largely on the various foreign methods for the gasification of pulverized fuel in fluid beds, or in suspension, because of the greater ease of handling, generally lower cost of fine sizes and higher gasification rates attainable.

"There are, however," the authors continue, "certain less desirable features of the pulverized fuel processes, such as the poor carbon efficiency, the relatively poor quality of the raw gas and the problem of removing the fines carried in the gas stream which up to the present have not been entirely overcome . . . .

"Although less publicized in the technical literature, work has progressed on several fixed-bed processes utilizing oxygen for continuous gasification and commercial plants have operated successfully . . . It is the purpose of this paper to present additional information regarding the production of hydrogen or synthesis gas by this process."

The gasification process is similar in most respects to standard producer gas operation, the major difference being that the conventional air-steam blast is replaced by an oxygen-steam blast. Operation differs but little from normal air-steam operation, and is characterized principally by the fact that with oxygen very much higher gasification rates are possible, appreciably higher quantities of steam must be used, and fuel bed conditions change much more rapidly. These various items are discussed in detail in the paper.

CERTIFIED ISO-OCTANE by the CAR LOAD

Article 1—Manufacture

By OTTO GERBES, H. J. HALL and A. E. BECKER

Distillation practices have been developed which make possible the production of iso-octane at high enough purity and low enough cost to make practicable the direct use of primary reference fuels in laboratory and road testing work. In the method now in commercial use 99.4% pure iso-octane is recovered from butylene alkylate feed stock in equipment available in the form of two fractionation towers of 45 and 50 actual plates each. The fractionation towers are operated in series, control of the system being based on material balance made possible by the relatively uniform composition of the butylene alkylate.

In a second article under the same title, to be published next month, tests used and precautions taken to maintain the purity of the iso-octane in handling, transportation and storage are discussed; also the results from a study of the composition of certified iso-octane to determine the effect of impurities present on octane ratings, and how the purity may be improved to 99.9% by a relatively simple distillation and filtering procedure, should the user have occasion to do so for purposes other than knock testing.

THE shortage of gasoline during the first World War directed attention toward improving engine efficiency and fuel economy. As the compression ratio of gasoline engines was increased to do this, fuel and engine manufacturers as well as consumers became keenly interested in the relative knock characteristics of fuels. This led to the development of methods of test for evaluating the anti-knock qualities of Motor and Aviation fuels. Of the many methods for doing this, reference fuels were generally used as standards of comparison.

At first each laboratory used an arbitrarily chosen gasoline as its standard fuel. The difficulties of comparing results from different laboratories and of reproducing the individual standard fuels soon became apparent. In a paper presented before the Division of Petroleum Chemistry of the American Chemical Society in September, 1926 (*Industrial and Engineering Chemistry*, January, 1927) Graham Edgar pointed out some of the advantages of using iso-octane (2, 2, 4-trimethylpentane) and normal heptane as primary reference fuels. He stated:

"In an investigation in this laboratory of certain pure hydrocarbons, it was discovered that chemically pure normal heptane (C_7H_{16}) has a pronounced tendency to knock greater than that of any commercial gasoline examined by this laboratory. It was also discovered that a certain octane (C_8H_{18}), as prepared in this laboratory, is a relatively nonknocking fuel. By mixing these two substances in varying proportions, it is possible to duplicate the knock characteristics of any commercial gasoline."

He further pointed out: "The two substances have boiling points so nearly identical that variation of the composition of the explosive mixture because of incompleted vaporization is not to be feared. The chemical composition of the two is so nearly identical that the fuel-air ratio is not materially altered by altering proportions of the two."

As a result of Dr. Edgar's work, the octane scale was adopted. Iso-octane of high purity was manufactured synthetically and made available by Rohm and Haas. A similar grade of normal heptane was prepared by the distillation of Jeffrey pine oil and marketed by the California Chemical Co.

These methods of manufacture were expensive and the primary fuels, iso-octane and normal heptane, were used mainly to calibrate secondary reference fuels. The latter have been in general use both for conducting laboratory tests and for road testing. It is possible to choose secondary reference fuels which have characteristics more nearly like those of commercial fuels than do blends of iso-octane and normal heptane, which is a definite advantage. However, there is the distinct disadvantage that such fuels must be calibrated for each method of test. This results in some confusion in interpreting road test data obtained with them.

Due to distillation practices now in use, the primary fuels are available in quantity at high enough purity and low enough cost to permit their direct use in laboratory and road testing, should experience prove this to be the better procedure.

Manufacture of Certified Iso-Octane

Hydrocarbon mixtures occurring in nature contain little or no iso-octane. On the other hand, synthesized products such as alkylate or hydrogenated polymers contain relatively large amounts of this compound. At present time the Humble Oil and Refining Co. has available at Baytown alkylates produced by sulfuric acid alkylation of butylenes, pentylenes and propylene. The major problem in producing pure iso-octane is, of course elimination of the compounds having boiling points near to that of the iso-octane. In Table 1, the boiling points and percentages of the critical compounds in typical alkylates are shown.

It will be noted that butylene alkylate contains about twice as much iso-octane as pentylene alkylate and about three times the amount present in propylene alkylate. While the percent iso-octane indicates the potential volume available in a feed stock, it does not necessarily

TABLE 1—Typical Total Alkylate From Sulfuric Acid Alkylation (Pentane-free Basis)*

	Atm. Boil. Pt., °C.	Butylene Alkylate, Vol. %	Pentylene Alkylate, Vol. %	Proplyene Alkylate, Vol. %
Lighter Material, >	81	14	7	33
2, 3-Dimethylpentane	89.8			
2-Methylhexane	90.1	3	2	38
3-Methylhexane	92.0			
2 2, 4-Trimethylpentane (Iso-Octane)	99.2	27	14	8
2, 2,-Dimethylhexane	106 8			
2, 5-Dimethylhexane	109.1	10	5	3
2, 4-Dimethylhexane	109.4			
2, 2, 3-Trimethylpentane	109.8			
Heavier Material, <	113.4	46	72	18
Total		100	100	100

*Based on API Research Project No. 6 analysis.

indicate the difficulty of separation. The ratio of the volume of adjacent boiling materials to the volume of iso-octane is a better criterion of the relative difficulty of separation. In Table 2, the volume percents of iso-octane and adjacent boiling materials in each of the alkylates have been converted to percentages based on the fraction consisting only of iso-octane and the adjacent materials.

Although the total pentylene alkylate contains less iso-octane, Table 1, the bulk of the material is relatively easy to separate and the materials which are difficult to separate occur in almost the same proportion relative to the iso-octane as the proportion in butylene alkylate. However in actual practice it is found that iso-octane produced on the same equipment using partially topped and undercut pentylene alkylate is approximately 0.3% lower purity than that from straight butylene alkylate. Thus, butylene alkylate has an advantage in purity as well as yield. This result has not been explained but may be due to the presence of small amounts of material boiling very close to iso-octane, not indicated in the analyses in Table 1. The propylene alkylate is obviously a poor feed stock, having a relatively low percent of iso-octane and a very high percent of adjacent heptanes.

Fractionation Requirements

The equipment available at Baytown for part-time production of iso-octane contains 45 and 50 actual plates. With this equipment it is possible to recover 53% of the iso-octane present in the butylene alkylate feedstock at a product purity of 99.4% iso-octane. A larger number of plates would make possible a much higher production rate. Under the conditions employed, plates are more critical than reflux ratios. Theoretical considerations and laboratory column distillation of butylene alkylate (Private communication from Dr. M. R. Fenske, Petroleum Refining Laboratory, Pennsylvania State College) indicate that yields of 75-90% of 99.5% iso-octane can be obtained by using reflux ratios (O/D) of 10 and 15 to 1 on columns having 50 theoretical plates. This is equivalent to about 65 to 85 actual plates, depending on the tray efficiency. However, availability of equipment must be taken into account when considering the most economical method of segregating iso-octane.

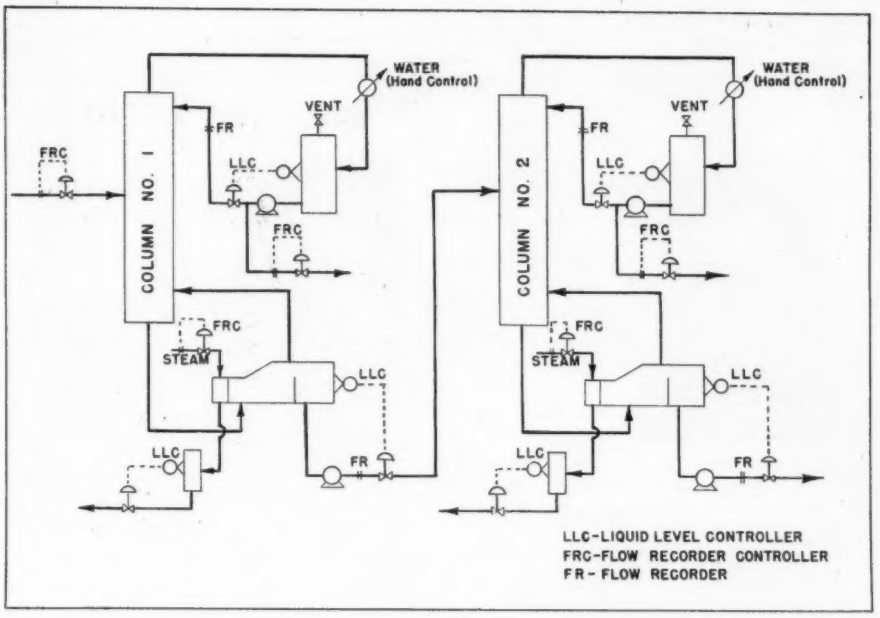

Fig. 1—Flow diagram and instrumentation for production of iso-octane

Commercial Production

The two fractionation towers, which are operated in series, are described in Table 3. As shown in Fig. 1, butylene alkylate is charged to Tower No. 1 on rate-of-flow control. Material more volatile than iso-octane is taken overhead, and the bottoms product is pumped to Tower No. 2 where the iso-octane is taken overhead. Material less volatile is discarded as a bottoms stream from Tower No 2. Control of the entire system is based on material balance made possible by the relatively uniform composition of the butylene alkylate.

The percent of iso-octane in the feed is known as well as the percent yield which can be obtained. This determines the overhead rate of Tower No. 2 as a fixed percent of the feed rate in Tower No. 1, making the overhead iso-octane stream well adapted to rate-of-flow control. The overhead rate from Tower No. 2 seldom requires changing unless the fresh feed rate to Tower No. 1 is changed. Although the percent iso-octane is known and is fairly constant, the position of the iso-octane fraction in the alkylate boiling range may shift somewhat because of the presence of a variable amount of isopentane in the alkylate; no attempt is made to depentanize the alkylate. Therefore, it is necessary to adjust the rate of withdrawal of overhead material from Tower No. 1 which is the stream containing the more volatile components. This stream is also on rate-of-flow control but is adjusted only when laboratory analyses indicate the need for adjustment or when the fresh feed rate is changed.

Operation of this system is best when using liquid-level control of the bottoms stream from Tower No. 1 feeding Tower No. 2. Obviously the liquid-level controller must be properly adjusted to give a uniformly smooth flow to Tower No. 2. Both towers are operated at maximum vapor rate as limited by tower capacity. This rate is determined by the steam to the reboiler which is on rate-of-flow control; the reflux rate is controlled by the reflux accumulator liquid level. Both accumulators are open to the atmosphere. Tower pressure drops are observed as an

Pilot plant operator registering a distillation cut of a certified iso-octane sample on the micromax chart. Readings taken are cut, time, still number, temperature

TABLE 3—Towers Used in Production of Iso-Octane

	Tower No. 1	Tower No. 2
Plates	45	50
Internal Diameter	8 ft.-6-in.	9 ft.-6-in.
Height	110 ft.-8-in.	117 ft.-0-in.
Plate Spacing	24-in.	24-in.
Feed Plate (From Bottom)	24	23

TABLE 2—Composition of Sulfuric Acid Alkylate Fraction Containing Iso-Octane and Adjacent Boiling Materials*

Typical Alkylate	Lighter Adjacent Material (89.8 to 92.0° C.) Vol. %	Iso-Octane (99.2° C.) Vol. %	Heavier Adjacent Material (106.8 to 109.8° C.) Vol. %
Butylene	8	67	25
Pentylene	9	67	24
Propylene	77	16	7

*Based on API Research Project No. 6

MEET THE AUTHORS

Otto Gerbes is a native Texan and received his MS in chemical engineering from the University of Texas in 1932. He was co-owner and operator of a small refinery outside San Antonio until 1939 when he joined the Technical Service staff of Humble Oil & Refining Co.

During the war he went to Africa to determine the effect of tropical conditions on aviation superfuel and later, when isobutane was a critical material in the wartime production of aviation alkylate, he was engaged in maximizing the national production of isobutane by isomerization of normal butane. He is at present senior chemical engineer for Humble, his primary responsibility being the technical co-ordination of light ends recovery, fractionation, alkylation and polymerization at the Baytown refinery.

Homer J. Hall graduated from Marietta College in Ohio and received his MSc and PhD from Ohio State University, where he was an assistant in the Department of Chemistry. He joined the staff of the Esso Laboratories Research Division in 1935 and has worked on the composition and analysis of motor fuels and the isolation and preparation of pure hydrocarbons, with several years being spent as a patent technologist.

During the war he worked on the analysis of alkylates and hydropolymers for aviation gasoline production and served as secretary of API Research Project 46 on "Hydrocarbons for Spectrometer Calibration". He is group leader in charge of Hydrocarbon Separations for the Process Research Section, Research Division of Esso Laboratories, Standard Oil Development Co.

A. E. Becker is an Ohioan, born in Lowell in 1886. He graduated from Marietta College in 1909 and received his MS and PhD degrees from Harvard, specializing in physics. He was an instructor in physics in Tufts College and in Harvard while working for his advanced degrees.

Dr. Becker was a physicist with the National Advisory Committee for Aeronautics in 1917 and was in the Army, Aviation Division, during the first World War. Following his Army service he was for a short time with the Aluminum Castings Co., Cleveland, as a physicist and then went with the Standard Oil Co. of New Jersey as a petroleum technologist and later with Standard Oil Development Co., where he has served in various capacities. Among outside technical duties he has been active in Committee D-2 of ASTM.

indication of approach to the maximum allowable vapor rate.

The system as described above requires relatively few laboratory tests. The percent iso-octane discarded in the overhead from Tower No. 1 is determined by mass spectrometer. The percentages of lighter and heavier impurities in the iso-octane overhead stream from Tower No. 2 are quickly determined by infra-red. The percent iso-octane discarded in the bottoms stream from Tower No. 2 is determined by Fenske distillation. Reping conditions are shown in Table 5.

TABLE 4—Representative Stream Inspections

Stream	Feed Fenske	Col. 1 Btms Fenske	Col. 2 Btms Fenske
Type Analysis Col.	8	4	4
Height, Ft. Charge,	2000	2000	2000
cc. Reflux Ratio	10:1	30:1	30:1
Vol. % Distilled		Top Vapor Temperatures	
0	72	210	210
2	80	210	210
4	115	210	210
6	133	210	210
8	173	210	210
10	184	210	210
12	192	210	210
14	202	210	210
16	206	210	211
18	208	210	217
20	208	210	
22	209	210	
24	209	210	
26	209	210	
28	209	210	
30	209	210	
32	210	210	
34	210	210	
36	210	210	
38	210	211	
40	210	213	
42	212	217	
44	219		

Stream:	Feed Material Balance	Col. 1 Btms Material Balance	Col. 1 Ovhd. Mass Spec.	Col. 2 Btms Fenske Dist.	Col. 2 Ovhd. Infra Red
Type Analysis:					
% Iso-octane	25.3	37.4	6.5	17	99.4
% Impurities:					
(1) Low Boiling					0.3
(2) High Boiling					0.3

resentative stream inspections are shown in Table 4. Routine analysis of the feed stock is unnecessary.

After the system is lined out, one test each day is obtained on Tower No. 1 overhead and Tower No. 2 bottoms. Three infra-red tests each day on the iso-octane overhead from Tower No. 2 are sufficient to indicate any changes required, usually in the overhead rate from Tower No. 1. These changes are indicated by the relative amount of lighter and heavier impurity in the iso-octane. The ultimate criterion of the product purity is the freezing point test which is tedious and exacting. The infra-red test is quick and has been correlated against the freezing point. Intermediate tray temperatures are observed to indicate changing conditions which might cause a low product purity. Pertinent operat-

TABLE 5 — Operating Conditions for Iso-Octane Recovery

Ratio, B/D	Tower No. 1	Tower No. 2
Reflux	9,700	10,500
Overhead	340	163
Bottoms	880	717
Charge	1,220	880
Steam (lb/hr)	20,000	21,000
Temperatures, °F.		
Accumulator	89	91
Top Vapor	164	211
37th Plate*		221
34th Plate*	225	
Reboiler	270	285
Feed	328	
Pressure, psig		
Accmlator	0	0
Reboiler	12	10

*Above reboiler.

WARREN

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TOMORROW

... IN PETROLEUM TECHNOLOGY

Current technological and economic developments discussed here in the light of their future bearing on petroleum refining operations include:

- **Petroleum naphthas finding increased use in oil extraction.**
- **Pigott stresses over-emphasis of octane numbers.**
- **Chemical product of Brownsville Synthine plant revealed.**
- **Data on xylidines presented at A.C.S. meeting.**
- **Petroleum chemical activity continues at unabated pace.**

Petroleum Solvents used In Oilseed Extraction

While "the processing of oilseeds has been a vital industry for thousands of years," only in comparatively recent years has solvent extraction been employed to any extent and only now is it coming into its own as perhaps the most important method of oil extraction.

As W. H. Goss(1) has pointed out, "the advantages of using solvents to extract oil from seeds have long been recognized, for extraction ordinarily permits the attaining of much lower residual content of oil in the meal than does pressing. Many seeds, however, are difficult to treat with solvents because of their physical structure or other characteristics. In addition, extraction is a more complicated process than pressing and has required much more developmental work on the design of suitable equipment in order to make it a practical method of operation. Only in very recent years have some of the most serious obstacles to its use been overcome, and in some applications there still remain many problems to be solved.

"The preferred solvent in most oilseed mills is a paraffin hydrocarbon comprised mainly of n-hexane, boiling at approximately 150° F. Goss brings out.

"Some German mills used higher-boiling paraffinic solvents before the war, and during the war they were forced to use synthetic hydrocarbons having a relatively wide boiling range and other undesirable properties. Paraffins of the proper volatility have been found, in general, to be the most efficient solvents for removing the oil, along with a minimum of non-oil material, and subsequently lending themselves to easy separation from the crude oil by distillation. They are extremely flammable, however, and can be used safely only by observing strict precautions against leakage and ignition of vapors which might escape . . ."

(1) Goss, W. H., *Solvent Extraction of Oilseeds*, U. S. Department of Agriculture Publication AIC-135, Northern Regional Research Laboratory, Peoria, Illinois, 1947.

Over-emphasis of Octane Numbers Stressed

In a paper presented at the recent Mechanical Engineering Conference in Pittsburgh,[2] R. J. S. Pigott of the Gulf Research & Development Co. states that the "octane value of gasolines to serve higher - compression - ratio engines, has been tremendously pushed for some years, and beautifully deceptive charts have frequently been published showing that all the gain in horsepower has been due to octane rating." Moreover, he points out that the "foolish idea" that 100-octane gasoline should be used in cars because it was needed for warplanes in the recent conflict "needs deflating."

"In the first place, 100-octane gasoline for general use would cut the total production 40 or 50% by present refining methods. This we could not possibly afford. Next there is no present engine designed that would be satisfactory for passenger service at compression ratios of 8.5 or 9 to 1, required to get the full benefit of 100 octane. The designers inform us that since rate of pressure rise increases sharply with compression ratio, they do not know how to control roughness in an engine at these high ratios."

Preignition is also an increasing problem at higher compression ratios. Furthermore, Pigott points out that "the law of diminishing returns is still operating;" the advance in compression ratio from 5 to 6.8, effected in the last 15 years, gave a theoretical increase of 15% in power or economy, but "we are now on the flat part of the curve, and less than 10% is all that can possibly be obtained by advance to 9:1. We should also take note of the fact that only 20% of the horsepower increase in the period 1930 to date has been from compression ratio; the rest is due to larger size, higher revolutions per minute, better breathing and manifolding, and other design improvements. Further, in heavy-duty vehicles (trucks and buses) the actual gain is only about 70% of the theoretical, and in the passenger car about 40%.

(2) Pigott, R. J. S., *Mechanical Engineering* 69, No. 7, 573 (1947) "Developments in Fuels, Lubricants, and Lubrication."

Pigott stresses that the tailoring of gasolines to suit the engines is more important than single octane numbers, that road ratings at speeds from 10 to 70 mph are needed to "get the characteristic octane rating of the gasoline with speed."

Also of importance is volatility, a property which must often be balanced economically with octane number in determining boiling ranges. In regard to fuel injection the statement is made that "until the injector system is about as cheap as a carburetor system, it will not see much application in gasoline engines," despite its advantages of "leaner average mixture, lower octane requirements and better economy (theoretically)."

Pigott believes, however that "there will be a moderate increase of compression ratio and octane rating," although "as matters stand, we have gasolines that are ample in octane value for all the present cars, new and old, and they are improving in volatility characteristics." Some of his views are in interesting and significant contrast to many of those expressed by the automotive industry and others.

Chemical Products of Synthine Plane Revealed

In further regard to last month's discussion of the fact that Stanolind will construct chemical separation plants at both its own Synthine plant in the Hugoton gas field of Kansas and the Brownsville, Texas plant of Carthage Hydrocol, it is more than interesting to note that U. S. Industrial Chemicals, Inc., has contracted with Stanolind to buy the entire output of water-soluble oxygenated chemicals which Stanolind will separate and refine at both Synthine plants.

Besides marketing these products, U. S. Industrial Chemicals, according to report, plans to erect plants "at both locations for production of other products, chiefly esters and higher alcohols, using some of the Fischer-Tropsch (Synthine) chemicals as raw materials."(3)

Production of chemicals at both Synthine plants may exceed 300,000,000 pounds per year; the Brownsville plant, for example, is expected to produce the following quantities:

	Lbs. per year
Acetaldehyde	9,100,000
Propionaldehyde	1,930,000
n-Butyraldehyde	3,750,000

(3) Anon., *Chemical and Engineering News* 25, No. 34, 2436.

Acetone	11,200,000
Methanol	730,000
Methyl ethyl ketone	4,780,000
Ethanol	63,680,000
n-Propanol	14,400,000
n-Butanol	4,370,000
n-Pentanol	1,060,000
Acetic acid	24,700,000
Propionic acid	8,700,000
n-Butyric acid	8,200,000
n-Butyl ketone	350,000
Methyl propyl ketone	600,000

"With the exception of ethyl alcohol, methanol, acetone, and acetic acid, these are chemicals which have never been produced in sufficient quantity, according to spokesmen in the industry, and they are needed for various new processes."(3)

According to NATIONAL PETROLEUM NEWS,(4) "Stanolind has not yet completed its plans for refining and marketing the higher molecular weight alcohols, acids, and ketones containing 5-12 or more carbon atoms per molecule which will be produced as by-products of the two synthetic gasoline plants. Stanolind's chemical recovery and separation plants will be completed in about two years."

First Data on Xylidines Is Presented at ACS

One group of the most hush-hush of all the aviation gasoline components used during the recent war were the xylidines produced from the xylenes which were obtained as by-products from the production of toluene by hydroforming. These xylenes were nitrated at various Ordnance Works (operated chiefly for TNT production), and the nitroxylenes thus produced were converted into the corresponding mixture of isomeric amines by various petroleum and chemical companies.

Very little data on these xylidines have so far been published, so that two papers presented at the American Chemical Society meeting last month (5), (6) should attract considerable attention.

The first of these papers(5) dealt with the development of a process of converting the nitroxylenes into xylidines by high-pressure hydrogenation. This work, conducted at Baton Rouge, Louisiana, by various subsidiaries of the Standard Oil Co. (New Jersey) led eventually to the development of production facilities capable of producing 150,000 lb/d of specification xylidines.

The high-pressure hydrogenation of nitroxylenes was conducted at about 3000 psig and 300-450°F., over a catalyst. During the course of the reaction, water had to be added along with the nitroxylene feed in order to control catalyst temperatures; because of this, a sulfur-resistant catalyst had to be developed for the fixed bed solid catalyst process employed. Essentially quantitative yields were obtained. Following distillation of the crude product, finished xylidine yields approximated 85-90% of the theoretical.

In the second paper,(6) a detailed description was given of the many factors which affect the quality and performance characteristics of the xylidines. Space does not permit inclusion of much of these data here, but it is highly pertinent to note that the authors stated that the xylidines are chiefly useful in imparting "marked improvement" to rich-mixture performance, and some slight improvement in lean-mixture behavior to gasolines of less than 100-octane.

For comparison purposes, the authors stated that 1% of xylidines is capable of extending Grade 100/130 aviation gasoline supplies by about 18 and 11%, respectively, when using as extenders Grade 91 and 87 naphthas (assuming lean-mixture performance not to be limiting). Further, they revealed that this percentage of xylidines is equivalent in rich-mixture additive power to 6% cumene or 10% xylenes or alkylate. However, 3.5-5.5% of xylidines are needed to give the same performance increase as the first 2 cc. per gallon of tetraethyl lead. Leaded gasolines, incidentally, are not as responsive as clear base stocks.

Petroleum Chemical Activity Is Unabated

Indicative of the continued activity in the field of chemicals from petroleum are the following brief quotations from a "news" feature of one of the leading chemical journals(7):

(1) Standard of New Jersey's subsidiary, Enjay Co. will soon market two new modified styrene-type polymers, to be known as "S-Polymers" for such uses as "films for wrapping fruits and perishable packaged foods, electrical insulation, surface coatings (including papers), and molded plastics."

(2) "Within the next few weeks the Koppers Co. will reveal its intention to make alkyl phenols and monochlorobenzene. The former will be produced at the company's Oil City facilities, the latter at the Kobuta Works."

(3) "At least three large petroleum companies are now busy working on the development of processes for separating aromatics from petroleum fractions by means of silica gel adsorption. Official announcements can be expected early next year."

(4) "Official comments will not be forthcoming for a full year, and possibly two, but a leading oil company is now laying plans to manufacture naphthalene from petroleum. Whether the naphthalene will be marketed as such or used as the base for further chemical manufacture has not as yet been decided."

(5) "Benzonitrile, being pilot-planted by Socony-Vacuum Oil Co., is only the first of a series of aromatic and aralkyl nitriles Socony intends to make from alkyl aromatics and ammonia."

In addition to the information contained in this news feature, *Chemical Industries* reveals in another feature article(8) that "petroleum gases have become the raw material for formaldehyde in two plants—Cities Service Oil Co. at Tallant, Oklahoma, and Celanese Chemical Corp., at Bishop, Texas. * * * The Cities Service operation oxidizes natural gas rich in methane, while the Celanese feed is propane or butane. It is probable that the (projected) McCarthy unit will use a feed similar to that used by Celanese."

Although these hydrogenation oxidation processes yield a variety of other chemicals; "the overall plant investment to separate this mixture into its many saleable components is very large;" and "the process operates at elevated pressure and requires much special corrosion equipment, the manufacturing cost for formaldehyde from natural gas by oxidation is very low, probably in the vicinity of one cent a pound when equipment depreciation has been charged in and credit taken for other products. With the oxidation of methanol (the chief present commercial process) the cost is appoximately double this figure with methanol at its present delivered price of 24 cents per gallon."

It is said that little formaldehyde will be produced at projected Synthine plants, since "in the main oxygenated products from these plants will be C_2 and higher."

The importance of petroleum as a source of chemicals may be derived "from the magnitude of the utilization of these materials in the solvents field. * * * About 5% of the country's methanol production, 50% of its ethyl alcohol production, 100% of isopropyl alcohol, 75% of acetone, 35% of normal butyl alcohol, and 90% of U. S. amyl alcohol production is synthesized from petroleum or natural gas. Approximately 100,000 tons annually of plastics are derived wholly or in part from ethylene. Some 30% of the toluene produced in the U. S. today is being made from petroleum."(9)

(4) Anon., NATIONAL PETROLEUM NEWS 39, No. 34, 16 (1947), "Stanolind to Build Two Plants to Make Chemicals from Gas."

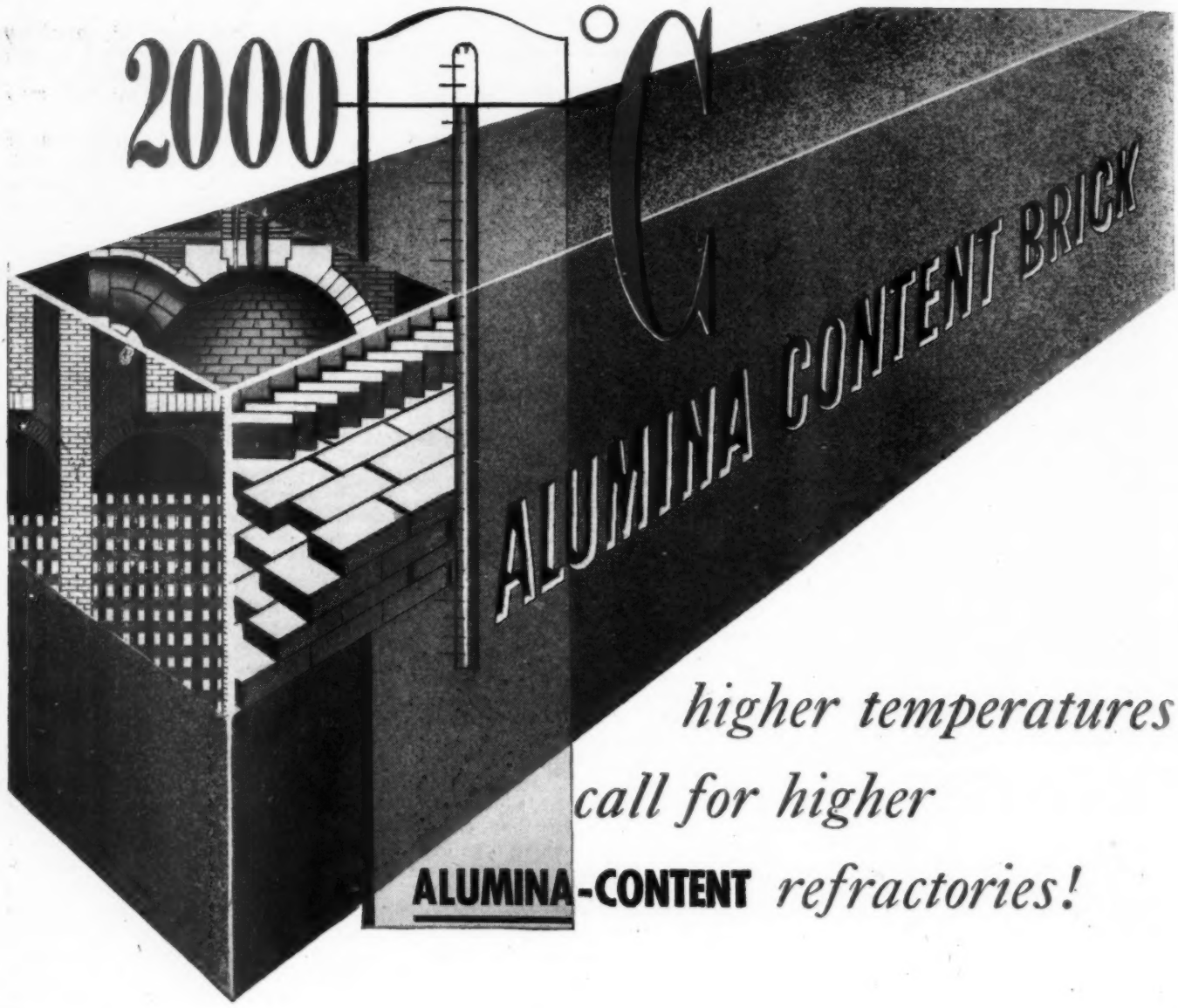
(5) Brown, C. L.; Smith, W. M.; and Scharmann, W. G., "Production of Xylidines by High Pressure Hydrogenation. I. Process Development." Paper presented before the Division of Petroleum Chemistry at the American Chemical Society Meeting, New York, September 15-19, 1947.

(6) Kune, J. F., Jr.; Howell, W. C., Jr.; and Starr, C. E., Jr., "Production of Xylidines by High Pressure Hydrogenation. II. Quality and Performance Characteristics," *Op. cit.*

(7) Anon., *Chemical Industries* 61, No. 2, 199 (1947), "Newsletter."

(8) Neidig, C. P., *Chemical Industries* 61, No. 2, 214 (1947), "Formaldehyde Presents a Changing Economic Picture."

(9) Burks, H. G., *Chemical Engineering* 54, No. 8, 266 (1947), "Chemistry in Oil Refining."



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PLANT PRACTICES

Practical Tips and Ideas for Improving Refinery Operations

Portable Scaffolds Speed Up Maintenance, Inspection, Insulation of Overhead Equipment

OVERHEAD maintenance work at Shell Oil Co.'s Wood River refinery is accomplished without the conventional time-consuming operation of building temporary wood scaffolds or the relatively hazardous method of working from extension ladders.

Shell uses two types of portable scaffolds, as shown in the photographs. One is an aerial platform mounted on a stake-body truck and used for general repairs and inspection of elevated lines and other structures. The other is specifically designed for insulating elevated lines running parallel to the ground.

Aerial Platform

The aerial platform was developed to answer the need for a scaffold of ready mobility to reach such places as, for example, leaky valves or flanges in overhead lines.

It is a truck-mounted scaffold, designed to fit between adjacent pipe supports, and extends 12 ft. above the truck bed. It is welded from salvage pipe and firmly secured to the truck bed on which it is carried. The working platform is 3 by 4 ft., made of wood bolted to a structural angle framework which in turn is clamped to the pipe supports to prevent horizontal movement.

Support for the frames is provided by telescoping pipe columns. These columns consist of approximately 8 ft. lengths of 1½-in., 2-in. and 2½-in. pipe telescoped together with the outside 2½-in. pipe welded to a baseplate and the two inside pipes projecting several inches above the top of the outside pipe. The 2½-in. and 2-in. pipes are slotted their entire length to accommodate eyes welded to the lower ends of the 2-in. and 1½-in. pipes.

A small hand winch welded to the outside pipe is used to raise the pipe sections. Cable from the winch is passed over a pulley fastened to the top of the outside pipe and connected first to the eye in the 1½-in. pipe. This is raised to the limit of its travel and pinned to the 2-in. pipe. The cable is then connected to the eye in the 2-in. pipe and is raised in the same manner until the desired height is reached, where it is pinned to the 2½-in. pipe.

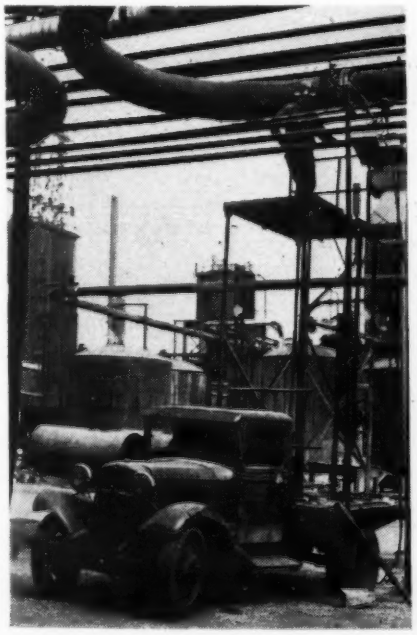
A railing of 1¼-in. pipe bolted to the opposite ends of the platforms with detachable chains on the other two sides and a steel extension ladder completes the structure. There is ample space left in the open spaces on the truck bed to carry any supply items or tools which can be handled by one or two men working on the platform.

Rolling Pipe Scaffold

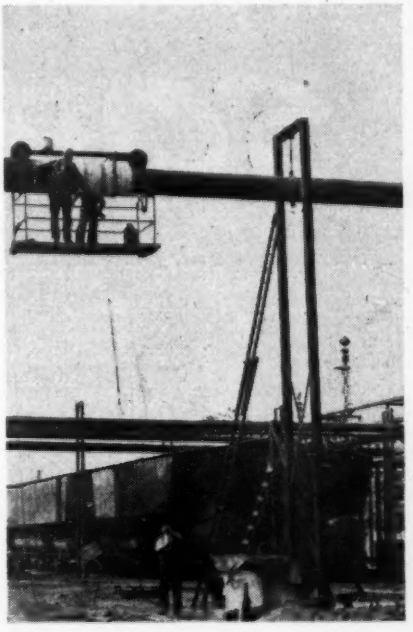
The rolling pipe scaffold was developed to meet the specific need for some means of insulating large overhead pipe without recourse to ladders or the usual wooden scaffolds. It consists of a wooden platform 3 ft. wide and 8 ft. long suspended by a suitable structural framework on a pair of pneumatic-tired wheels which roll along the top of the pipe and enable it to be moved as the work progresses.

To permit the scaffold to be rolled past pipe hangers, two sets of mounting holes about 2 ft. apart are provided at each end. When a hanger is reached a third wheel is installed in the alternate mounting hole at the end toward the hanger and the end wheel is removed. The scaffold is then rolled past the hanger far enough to reinstall the end wheel and the temporary third wheel is removed. This operation is repeated as the other end of the scaffold reaches the hanger.

The use of this scaffold for insulating large lines has saved the cost of erecting wooden scaffolding and eliminated one craft normally required for this work. It has also eliminated interference with work or equipment on the ground below.



LEFT, aerial platform used by the Shell Oil Co. at its Wood River refinery for general inspection and repairs on elevated lines. It is built of salvaged pipe, and extends from 7 to 12 ft. above the bed of the truck



RIGHT, rolling scaffold for pipe insulating jobs at Shell's Wood River plant saves time and materials required for erection of conventional scaffolding, and eliminates necessity of blocking traffic in road below

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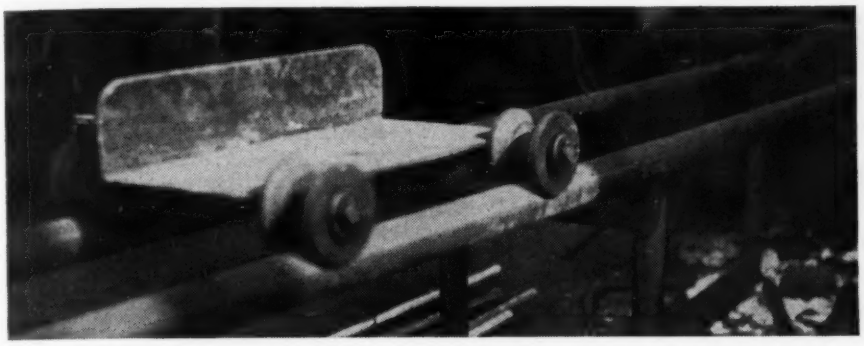
Sturdy Carriage to Hold Work in Alignment Simplifies Operation of Power Hacksaw

By JOHN C. ALBRIGHT



Better alignment for feeding material to power hacksaw is provided with this track and carriage developed at Norwalk, Calif., refinery of Wilshire Oil Co.

POWER driven hacksaw operation can be simplified and controlled to prevent the breaking of blades or dropping of material and to insure a true cut at the marked line when the tail end of the material being cut is supported solidly to eliminate vertical and lateral movement.

This is done in the pipe shop of Wilshire Oil Co., Inc., in its refinery near Norwalk, Cal., where mechanics have designed and built a double track and a grooved wheel carriage to support the pipe or other material as it is fed to the saw.

The track upon which the grooved wheel carriage operates is constructed of two horizontally-placed lengths of 2" pipe, selected for its smooth exterior, freedom from pits, scale or other blemishes so that the wheels will roll smoothly from one end to the other in perfect alignment with the power saw frame.

Three pairs of vertical supports carry the carriage tracks, and are tied together with crossmembers securely welded to the vertical members. The supporting sections are set in holes drilled in the concrete floor of the pipe shop. They are accurately cut and set so that, when the horizontal tracks are laid down for welding, the entire assembly is in direct alignment with the material vise on the power saw frame.

The carriage is made with a flat bed, cut from a clean sheet of heavy steel to obtain a smooth surface without flaws. It has one vertical side board so that a heavy "C" clamp can be used to hold material solidly in position without vibrations.

The axles are solid rods, welded to the underside of the bed of the carriage and fitted with grooved wheels, one on each end, so that a four-point suspension is obtained.

The wheels are turned out on a lathe from solid bars of steel, such as salvaged pump rods. They are in the shape of deeply grooved spools with the flanges beveled so that the point of contact between the wheels and the track is on the inside of the bevel instead of on the cylindrical body between the flanges.

The carriage body is kept solidly in direct position by retaining discs welded to the axles near the bed and on the inside of the wheel. The wheels are prevented from slipping by heavy washers and cotter pins in drilled holes near the outer ends of the axles.

Material is supported by the carriage, which may be moved easily the full length of the track, and is kept in the correct position with no strains on the material vise. The result is that the cut is made cleanly with no damage to material or saw blade, which happens frequently when the pipe or material is supported on improvised stands such as saw horses or oil drums.

Plant operators, foremen, superintendents—Send in your own contributions on "how we do it around our refinery." Send your money-saving and time-saving ideas to:

Plant Practices Editor
PETROLEUM PROCESSING
1213 West Third Street
Cleveland 13, Ohio

Water System Instrumentation Costs Cut By Use of Differences in Line Pressure

By ALFRED KRIEG, Supervisor, Instrument Department
Socony-Vacuum Oil Co., Inc., Paulsboro (N. J.) Refinery

VARIATIONS in line pressure were utilized as an economic means of instrument operation and level control of a treated-water tank recently installed in a remote section of the Socony-Vacuum refinery at Paulsboro.

Because the tank was located several thousand yards from the source of supply—a cooling tower—the installation of conduit or air lines between the two points for operating instruments was considered impractical and the cost prohibitive.

The elevation of the cooling tower provided sufficient pressure to maintain the desired level in the tank by gravity flow under normal operating conditions, as controlled by the level instrument. See Fig. 1.

However, if the head at the cooling tower drops below 15 psig, it is necessary to start the electric booster pump to supply the water to the tank. This is accomplished by the differential pressure switch set to close at 15 psig. The pump

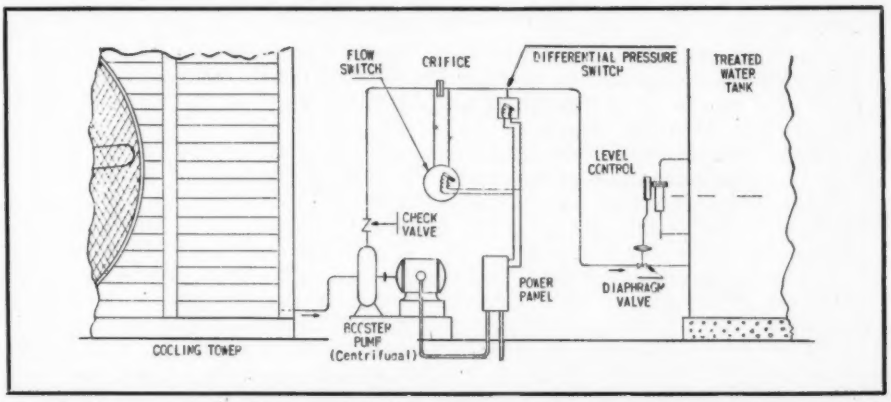


Fig. 1—Pressure variations control flow from cooling tower to treated-water tank. Tower is at considerable distance from tank, making other instrumentation systems costly

will then continue to run until the demand is satisfied.

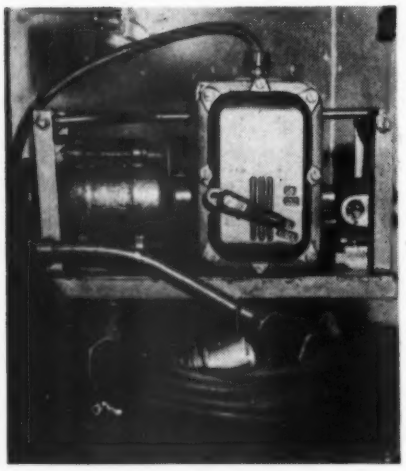
When the level is above normal, the diaphragm motor valve near the tank is in the closed position, and the booster pump will operate against a closed discharge. This causes the line pressure to increase, opening the differential pressure switch and shutting down the pump, momentarily bottling up the pressure in the line between the check valve and the diaphragm motor valve.

Flow limiting devices are installed on treated water lines to refinery units to assure a normal rate of flow and to prevent draining the supply. As a measure of the total flow was required for accounting purposes at this unit, a mercury switch was installed within the flow meter case and connected to shut down the pump when a predetermined rate was exceeded.

Such a shutdown continues for a 15-minute interval, controlled through a time delay relay in the motor control panel, after which the pump will resume operation if required, until the demand is satisfied or the rate is excessive again.

Oil Changes on Big Engines Made Easy With Shop-Built Portable Pumping Unit

GEORGE CUNNINGHAM, Socony-Vacuum Oil Co., Inc.
Lubrite Division, East St. Louis, Ill.



Only 12 x 24 in., this small pumper can be moved easily to any large engine or compressor for a lube oil change

REMOVING lubricating oil from crankcases of large engines and compressors is a slow job with much hand work, because the oil ordinarily is handled many times in withdrawal. Unfortunately such engines cannot be put on a hoist and drained like those in an auto or truck.

At Lubrite we have developed a portable suction pump for the purpose, which also can be used for handling other liquids. This unit, shown in the photograph, consists of a 440 volt, 3-phase, A.C., explosion-proof motor rated at ¼-hp., direct-connected to a 1-inch Worthington "GI" rotary pump.

Pump and motor are mounted on a truck, 12-in. wide by 24-in. long, supported by four heavy-duty casters, which was fabricated in the plant. As much hose and power cable as needed are connected.

This unit is intended for use in plant locations where the only power available is 440 volt A.C. This requires the use of an approved explosion-proof switch which, in this particular application, is large and adds much to the weight and size of the assembled apparatus. Any ¼-hp. explosion-proof motor would be satisfactory. Using mostly salvage materials, the unit can be built complete for $50. When high voltages must be used, current handling equipment as well as the motor will cost more.

In use, the suction line is inserted into the engine crankcase and the discharge line in a barrel or other container. To return the oil, when it has been drained to permit work on the engine, the lines are reversed. Unit can be used at regular drain periods, too.

Reduce Repairs to Acid Pump When Using Seal-Oil as Purge

MAINTENANCE can be reduced and safety for repairmen improved by purging acid pumps with seal-oil, according to an idea submitted by C. H. Miller of the propane lube plant at Humble Oil & Refining Co.'s Baytown refinery.

Miller suggested a tie-in to the pump suction from the regular seal-oil system installed for sealing and lubrication of packing glands on these pumps. Use of this oil in idle pumps would reduce valve damage from corrosion and minimize sticking, he claimed. By purging with oil all the acid would be removed, lessening the possibility of maintenance workers sustaining acid burns when working on the pumps.

However, when the idea was first put into practice it developed the serious objection of lowering seal-oil system pressure. This resulted in excessive acid leakage from other pumps while purging was taking place, and in several cases gaskets on the other pumps were so distorted by the pressure differential that they no longer held.

The procedure was then modified so as to provide the purging oil from the main supply system, ahead of the seal-oil pump. This modified procedure has worked in a satisfactory manner. The oil used for purging is discarded because of its acid content. Installation cost is said to be negligible, and the only continuing expense is represented by the value of the discarded oil.

Speed Up Dismantling of Heat Exchangers Through Use of Longer Type Flange Nuts

TIME involved in removing return bend flanges from heat exchangers at the Marcus Hook refinery of Sun Oil Co. was cut over 90% by substituting 1-in. flange nuts with a 3-in. side for the conventional nut with a 1-in. side.

As shown in the sketch in Fig. 2, the shorter nut fits too close to the return bend to allow the use of a ratchet or impact wrench. Using the only hand tool that would fit, an open end wrench, maintenance men could only make a 1/6 turn with each bite on the nut.

With the revised nut, sufficient clearance was obtained so that a ratchet wrench could be used. The revised nut has a solid end to provide the strength required in the longer size. However, it was necessary to drill a ¼-in. hole through the solid end of the nut to relieve air pressure which built up and resisted tightening of the nut.

The new type of nut has proved so successful that Sun is having it made up in large quantities by a large manufacturer.

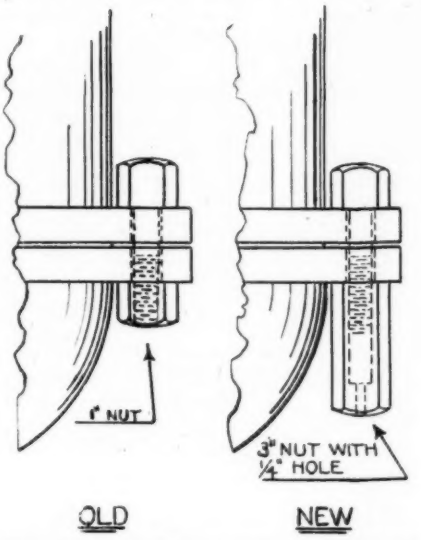


Fig. 2—New flange nut for heat exchanger return bends provides clearance needed by ratchet wrench, speeds up dismantling

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Results of "What's Wrong?" Contest

THERE were 17 different ways for those welders shown in the posed picture in the August PETROLEUM PROCESSING "What's Wrong?" Contest to be injured or to start a fire.

Although no professional safety men were among the entries, the sharp eyes of refinery inspectors, foremen, supervisors and engineers didn't miss a trick. None of the winners caught all 17 unsafe practices; however, even the less obvious errors were noted by at least three persons.

Three items were seen by everyone: (1) the drum as an unsafe support, (2) the rods in the welder's breast pocket, and (3) the electrode holder hanging over the pipe.

A copy of "The Procedure Handbook of Arc Welding and Practice" will be mailed to each of the following ten readers who sent in the most complete list of bad practices.

HERE ARE THE WINNERS . . .

J. F. Williams, Zone Foreman, Atlantic Refining Co., Philadelphia, Pa.

Peter F. Krol, Senior Engineer, Tide Water Associated Oil Co., Bayonne, N. J.

William F. Kramer, Chief Inspector, Pure Oil Co., Toledo, Ohio.

Ira J. Kirkman, Lago Oil & Transport Co., Ltd., Aruba, Curacao.

H. J. Fernandez, Inspector, Crown Central Petroleum Corp., Houston, Texas.

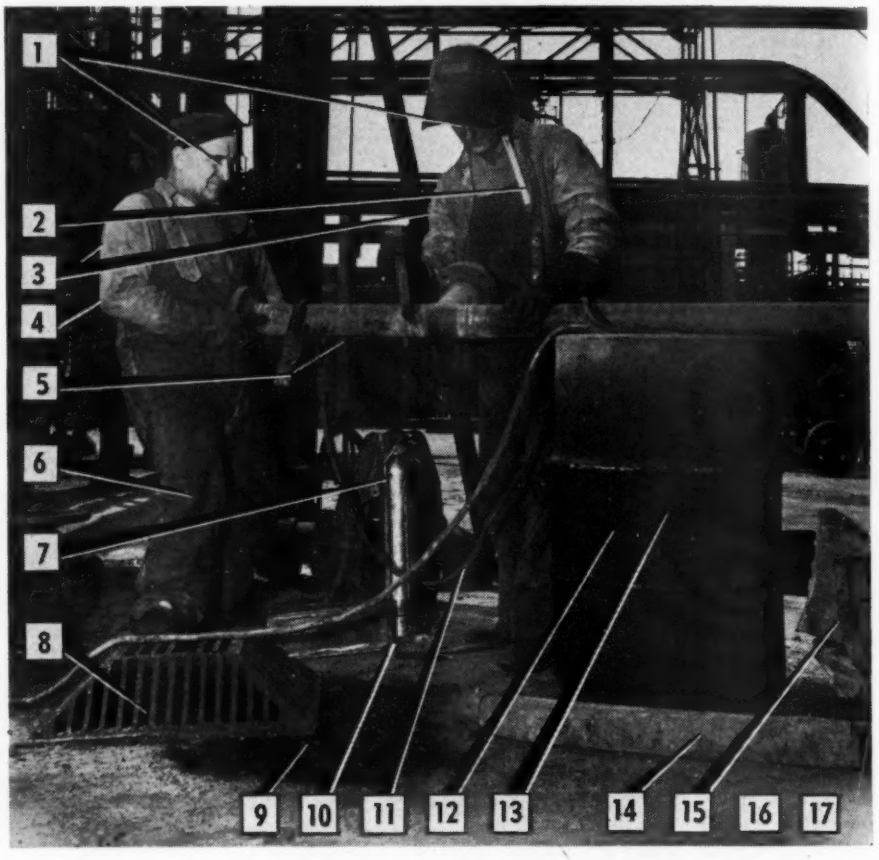
Marvin J. Lynch, Woodbury, N. J.

John J. Hoerter, Senior Engineering Inspector, Standard Oil Co. (N. J.), Linden, N. J.

Thomas H. Whaley, Jr, Mt. Vernon, N. Y.

George Morrice, Jr., Industrial Relations Dept., Standard Oil Co. of California, El Segundo, Calif.

Richard H. Tubman, West Orange, N. J.



HERE'S WHAT'S WRONG . . .

(Note: Numbers on items listed below correspond with numbers shown in photograph above)

1. Neither man is wearing eye protection — necessary because of wire brushing and chipping as well as because of possible arcing of electrode. Goggles should be worn at all times, even under a welder's mask.

2. Welding rods in the breast pocket are a serious eye hazard, or may injure the workman's face.

3. It is good practice to wear neat and clean clothes. Loose clothing is hazardous on any industrial job; oily and greasy clothing is dangerous on welding jobs.

4. The helper should not be holding pipe; he should be free and on the alert for fires.

5. Hanging the electrode holder across the pipe with the electrode still in it is an excellent way to cause an accidental arc which might injure the eyes of either workman. Electrode should be removed and holder placed in safe position.

6. Helper is in an awkward position with all his weight resting on his left leg. And he may be shocked in case of a short circuit because his right foot is grounded on a metal grill.

7. The fire extinguisher is near enough to be readily available; it is of a satisfactory type—foam (although a non-conducting type such as carbon dioxide or dry powder would be better), BUT a fire extinguisher is not a coat hanger. Speed is essential in a fire, and the coat would slow up use of the extinguisher.

8. The job is set up too close to an open sewer—a fire hazard because of flammable fumes or gases which may ignite. Sewer should have been tightly closed, or covered with a wetted tarpaulin. Better still, job could have been done in a safer, less-congested area since pipe is obviously easily transportable.

9. Oil spillage near the sewer should have been sanded down, cleaned up with some asbestos absorbent material, or washed away with water to eliminate possibility of its igniting from a spark.

10. The tools and electrode box are too close to the work area, cluttering it up, and presenting a stumbling and falling hazard.

11. The manner in which the welding cable is strung and twisted about the work area is not only a serious stumbling and falling hazard, but the cable insulation will be badly worn making possible a short circuit.

12. Use of an oil drum as a work support is unsafe. Some sturdy platform or rigid means should have been used. The helper would then be free and there would be no danger of the pipe falling and injuring the welder.

13. In addition to being an unsafe support, the drum may contain waste oil or gasoline fumes and be an explosion hazard.

14. Although the fire hose is unreeled, it is unusable without a nozzle. Or, it might have been wise to use it to flow water over the ground area during the job so as to kill stray sparks.

15. The refuse and empty insulation container is another fire hazard and should have been properly disposed of before the job was started.

16. Not visible is the very important grounding wire connection between the work and the ground.

17. Also not seen is a welding shield which would protect the eyes of other workmen and passersby.

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No one can say how long a time, measured in days, months or years, a certain valve will give satisfactory performance. Naturally it will depend on the service conditions—how much the valve is operated and especially the kind of media it controls.

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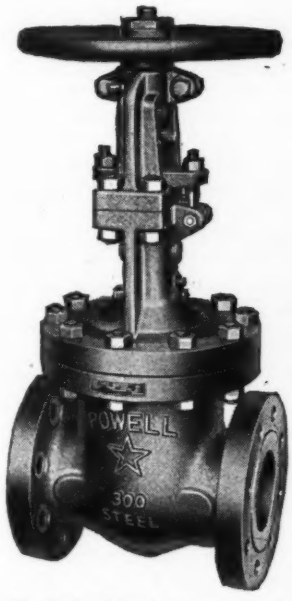

Fig. 3003—Class 300-pound Cast Steel Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke, taper wedge solid disc.

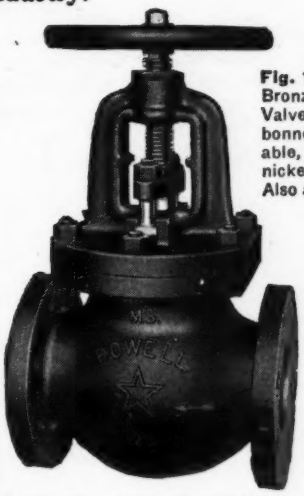

Fig. 241—Large 125-pound Iron Body Bronze Mounted Globe Valve. Made in sizes 2" to 16", incl. Has outside screw rising stem, bolted flanged yoke and regrindable, renewable bronze seat and disc. Also available in All Iron.

Fig. 190—150-pound Iron Body Bronze Mounted "Irenew" Globe Valve. Has screwed ends, union bonnet and regrindable renewable, wear-resisting "Powellium" nickel - bronze seat and disc. Also available in All Iron.

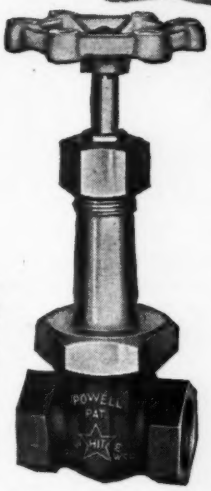

Fig. 375—200-pound Bronze Gate Valve. Screwed ends, inside screw rising stem, union bonnet and renewable, wear-resisting "Powellium" nickel-bronze disc.

Fig. 1793—Large 125-pound Iron Body Bronze Mounted Gate Valve. Made in sizes 2" to 30", incl. Has outside screw rising stem, bolted flanged yoke and taper wedge solid disc. Taper wedge double disc can be provided in sizes 2" to 12", incl.

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POWELL VALVES

Modernizing of On-the-Job Training Programs Undertaken by API Group

Much emphasis is being given today by oil companies to setting up good on-the-job training courses for refinery workers. It is recognized that the technological advances in refining that were made under the impetus of meeting wartime requirements, together with the improvements in many of the crafts, have made the pre-war refining training programs entirely obsolete. Also, the general technique of training workers *after* they have been employed has improved a great deal.

To aid the individual companies in modernizing their training courses, the American Petroleum Institute General Refining Committee has set up a Special Committee on Training in Refining. Among other duties this group is now making a survey of what is being done by individual companies and will put out a report to expedite the general improving of training courses. The first report of what this special committee is doing was made at the meeting of the API Refining Division in St. Louis, June 2-3. It has just recently been made public and is published below:

By HARRY D. KOLB
Standard Oil Co., of New Jersey
Chairman, API Committee on Training in Refining

THE API Committee on Training in Refining has set up plans to conduct several surveys. One has been the survey of training practices, to be conducted by a university, so that you can see what the other companies are doing, what they are thinking, and how much effort they are putting into this phase of their business. We are all familiar with the fact that there were many training films developed in recent years.

In addition, there are many sources of federal and state aids available to each of the plants through vocational schools, state departments of education, and universities. Our committee feels that not enough is being made of the federally-financed and state-supported aids, and we propose a survey to show you how to get the aid in your own state.

One reason for the increased emphasis on this phase of the refining business is simply this: A lot more money and effort is being spent on training. In this direction, the petroleum industry is not the leader. Other companies have shown that it is good business, however. You find companies like International Business Machines spending $2,500,000 a year on training; Ford spending $5,000,000. You find companies like International Harvester taking this thing seriously enough to make a contract with the colleges for research—they have just made one with the University of Chicago for research on training techniques and direct help to their plant staffs.

Some oil companies have started in this direction. One company now, in one center alone, is spending $500,000 a year. Several other oil companies are operating training centers. There is a significant trend here, apparently based on the fact they find it is good business—both from the viewpoint of absorbing people and making them productive sooner.

There are other trends in this training which we should like to keep the Institute aware of. One is that the plant manager and the company president need to be more aware of training developments. You will find in your management circles that training now has to go on the agenda of operating meetings. Plant superintendents are spending as much time with training as some of the technical jobs with which they are normally concerned. Second, if you are going to spend money as some of these companies are, then you need an overall plan as a guide. Too often in the past, training has run at the whim of some executive. Some overall philosophy of guidance is now the order of the day.

Money is being spent particularly in the direction of qualified training staffs. The custom in the past of entrusting the training of foremen in the hands of some clerk who receives half the salary of the lowest-paid foreman is being frowned upon now, and rightfully so. There is a feeling that some of this training work requires professional help. Better techniques are being required in the training programs conducted today. For one reason, those men who were in the army were exposed to some good training, and are now back and impatient at some of the training techniques which have been used in industry. Another reason for better technique is to get a good return on a large investment. When you stop and figure out how much a training meeting costs, you will arrive at a figure something like $2 per minute. Sometimes it runs close to $3.

In view of that cost, some people are beginning to realize they should spend more on the facilities and technique in order to make the training session worthwhile.

One way of doing it is investing in better instructor and conference training for general foremen. Also it means spelling out what you mean by on-the-job training, so that there is really an organized plan. The superintendent should be able to walk in and say: "Who is in this program? How far along are they? When are they going to finish? Let's measure what we are doing."

Another significant trend is the emphasis on training from the top down. One company finds it worthwhile to send its general foremen to a program intended for its foremen. The company wants to train from the top down, so the general foreman will observe the good practices they expect their foremen to follow.

Another trend which we think is significant is the willingness to spend a little more effort on the orientation of engineers. This means letting them know something about the corporate side of the business, about the organization of the company, and about its history. It need not stop with just the engineers; some companies give a similar orientation to clerical personnel as well. This is based on the fact that your employees will have a stronger interest in their job if they have more confidence in the organization—which they will get if you tell them more about it. There seems to be a trend now to be willing to dust off the organization charts and take them out of the drawer and let the people see how the company really works.

Another trend that is rather interesting is the willingness to take a man off the job for training. In one place there have been 300 foremen, in small groups of 16 men, taken off the job for 2 weeks in order to give them a concise and concentrated course in the art of supervision and what is expected of them as a supervisor. It is not just taking them off the job; it is taking them to a hotel, putting them on an expense account, treating them in a way that improves their status as a member of management.

One other practice on which we hope to be able to report more to you at the next session is the problem of indoctrinating our people with better philosophy regarding the American system of business and the basic economies of industry.

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Improved Plant Instrumentation Practices Are Presented at ISA Conference

A STAFF REPORT
by the Editors of
Petroleum Processing

Petroleum refinery instrument men are playing a leading role in the rapid progress being made in industrial instrumentation, it was brought out at the Second National Instrument Conference and Exhibit, sponsored by the Instrument Society of America at Chicago, Sept. 8-12.

Improved methods for using and servicing instruments being developed in the petroleum processing and other industries provide a practical means for increasing plant operating efficiency, it was shown. Possibilities along this line presented in papers by oil company technologists were:

1—Increased standardization of instruments so as to reduce the use of many specialized types and find wider application for conventional instruments.

2—Standardization of instrument maintenance and repair parts, of installation layouts and of fixtures, to lessen servicing costs.

3—Use of still more recording and control devices such as those based on viscosity, for example.

Other information of interest included the use of radioactive isotopes as tracers and in other techniques in commercial applications, and a new improved design for a calibrating manometer.

A highlight of the conference was a demonstration of an instrument training program using large-scale working models coordinated with simple layout diagrams. Developed by Eastman Kodak Co., the educational method explains in an understandable though technical, manner the operation of various automatic control devices. Remarks by members of the extra large audience at this particular session indicated that the method could be employed in the training program of almost any industry.

Of even greater interest than some of the technical sessions were the new and improved instruments on display in the exhibit. Nearly 140 manufacturers showed their line of products from simple thermometers and valves to the latest type of fully automatic controllers and measuring devices.

Almost half the companies sponsoring exhibits manufacture equipment of general use in the petroleum refining and petroleum chemicals industry.

Registration was almost double that of the first Instrument Society of America conference and exhibit in Pittsburgh, September, 1946. An estimated 7000 persons visited the show and heard 26 papers during the nine technical sessions of the ISA, and the two technical sessions held jointly with ISA by the Industrial Instruments and Regulators Division of the American Society of Mechanical Engineers.

Brief condensations of some of the papers of interest to petroleum refiners follow.

Conventional Controls Practicable For Most Refinery Power Plants

"Application of Conventional Industrial Instruments to Power Plant Control," by W. H. Fortney, General Foreman, Instrument Department, Humble Oil & Refining Co., Baytown, Texas.

THE field of power plant control has been largely covered by specialized devices which have been limited in application, Mr. Fortney pointed out.

Most of these instruments are of extremely rugged design and are seldom used in general process work. But at present, few power plant engineers are familiar with, or interested in, conventional industrial instruments such as are used in the chemical and process industries.

The author believes that there is a need for standardization of instruments. "Every steam plant as well as every process plant, has at least a few special instruments designed for one particular job which would be practically worthless if the process were revised or discontinued," he explained. "The ideal situation would be one where every instrument is 100% reclaimable."

Baytown refinery has been able to use conventional instruments successfully on most of the usual power plant applications, and Mr. Fortney's paper described some of these installations.

In one set-up, a water treating plant for two 350,000 lb./hr. boilers, a change to conventional orifice meters cost about 25% of the original installation and provided continuous proportioning of chemicals with instantaneous response to changes in water flow.

In one steam generating plant, consisting of four 600 psi. boilers, fire control is complicated by the fact that acid sludge from the refinery must be burned. This sludge contains coke, asphaltic materials, and other disposables, all of which are difficult to measure on flow or pressure; it is therefore on hand control at the burners.

The additional heat comes from the yard fuel gas system and is on automatic control. The boilers were all originally on remote manual fire control.

Three are now on fixed output control, fired on rate-of-flow control from the boiler leads. The rate-of-flow controllers operate conventional pressure balanced diaphragm valves on the fuel gas. This is, as far as Mr. Fortney has been able

to check, the first application of rate-of-flow control to steam production. The fourth boiler is fired by pressure control on the high pressure steam header, through a balanced valve identical to the others.

Three 7500 kw turbines are supplied from the 600 psi header, and discharge into the 150 psi yard system. Three de-superheaters handle the excess 600 psi steam. Temperature on these units was originally controlled by bi-metallic thermostats. These have now been replaced by conventional mercury bulb temperature controllers actuating water injection to the de-superheaters.

In another water treating plant, rate-of-flow control instruments have replaced an original acid proportioning device which consisted of an integrating flow meter operating intermittently a series of helicoid gear pumps to inject acid into a small mixing vat.

Mr. Fortney described a number of novel ideas that were worked out in another high pressure boiler plant. Operators have installed orifices in the blowdown lines and proposes to control the blowdown by its ratio to feedwater. This is a very desirable improvement since it would effect economies in the heat balance and a blowdown stream of consistently solid content would result, he said.

Automatic cycle control of the filters is also possible and very desirable. This could be accomplished by using pressure differential transmitters across the filters, which would start cycle controllers to backwash the filter beds, purge them, and put them back on the line. Some very real manpower savings are possible with a system of this kind; at present, the operators must manipulate a number of large gate valves with each filter change.

Considerable flexibility in operation throughout the refinery's steam plants has been obtained by adapting the valves and controllers for remote positioning as well as for control by the conventional instruments.

Efficiency of Equipment Is Increased By Standard Installation Methods

"Instrument Installation and Maintenance Methods and Practices in a Modern Oil Refinery," by G. A. Larsen, Instrument Foreman, The Texas Co., Lockport, Ill.

DEPARTMENTAL and new equipment efficiency can be improved and appreciable savings in time and material realized by a number of methods and practices which were adopted by the instrument department at The Texas Co.'s Lockport refinery, according to Mr. Larsen.

Among the practices described were 1) standardization of installation methods and piping arrangements, 2) stocking a sufficient supply of standard repair parts and fixtures, and 3) provision of adequate shop facilities and a workable training program.

Working drawings of the pipe layouts are kept on file and issued to installation men as assignments for such jobs are made These various layouts have been designed according to the type of instrument to be installed and the kind of service it is to give. A typical drawing is shown in Fig. 1.

Working drawings are also kept on file for making various standard accessories, fixtures, and the like. A supply of these items is kept on hand for ready use on each new installation. As the supply runs low, orders for a new batch of the item needed are sent to the crafts involved in its manufacture.

For example, a design for a standard wall bracket for mounting meters and transmitters has been adopted. The brackets are kept on hand as stock items, thus eliminating the previous practice of assigning steel men or pipefitters to mount an instrument using a bracket of their own individual design.

In the same way, a supply of seal pots, condensation pots, and mercury traps is kept on hand and drawn from as needed. Use of the mercury trap was cited by the author as a case where as much as $2000 per year in lost mercury was saved.

The Lockport instrument department also developed and built a number of "gadgets" and special tools which save time and material in the maintenance and repair of instruments. One was an orifice tap cleanout device permanently placed in the flue gas line of a hydroforming unit where frequent removal of coke was necessary. Another was a plant-built instrument air cleaner developed during the war when commercial devices were hard to get. Still another was a spanner wrench for rapid removal of gage covers to speed up inspection of the better than 3000 gages in the plant.

Properly designed shop facilities and a satisfactory program of training and upgrading instrument mechanics assures the foreman of efficient personnel, Mr. Larsen said. The training course couples

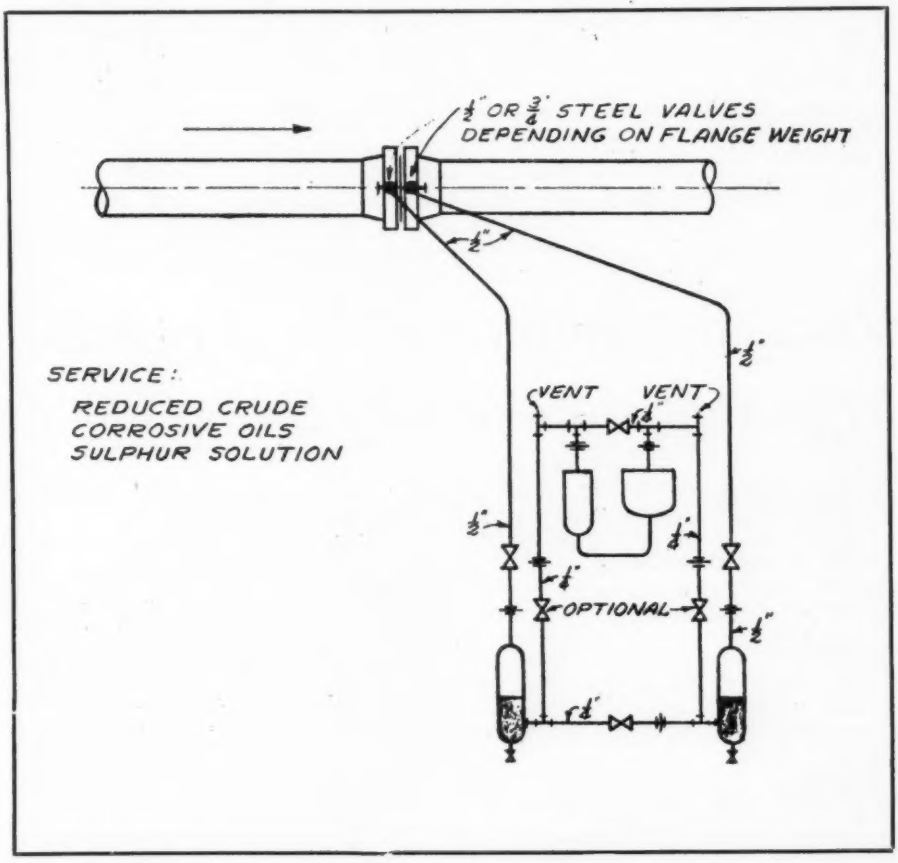

Fig. 1—Typical piping arrangement as used for one type of service in meter installations at The Texas Co.'s Lockport refinery. Layouts such as this are kept in file for issue whenever installation is to be made

work in the field with study in the classroom. It includes such subjects as elementary physics, basic electricity and electronics, mathematics as required, and elementary chemistry as far as needed to cover the servicing of such equipment as pH recorders and typical gas analyzers. The classroom is actually a laboratory with demonstration models of various instruments used in the refinery.

Floating Scale Manometer Is Useful For Precise Instrument Calibration

"Floating Scale Manometer," by W. D. Wood, Director, Standards Laboratory, Taylor Instrument Co., Rochester, N. Y., presented during the meeting of Industrial Instruments and Regulators Division of the ASME Chicago, Sept. 8-9.

THE paper describes the development and design of an improved cistern type manometer which would have its greatest application in the laboratory for the testing and calibration of industrial instruments.

Conventional manometers are read by comparing the position of a liquid surface against a fixed scale. The new instrument utilizes a moving scale supported on a float which rides with the liquid surface. This reversal of scale and index allows constant reading level, the use of metal tubing for liquid legs, and the simple addition of a thermostatic cabinet which does not interfere with the reading area.

The primary advantage of fixed index with fixed reading level overcomes possibilities of error because the test operator does not always adjust his eye level to each new level in the conventional instrument. In construction, the device requires a small vibrator to assure freedom of vertical movement for the floating scale. A cutaway view of the new manometer is shown in Fig. 2.

A number of 25 psi. range floating scale manometers using mercury and some of lower ranges using other liquids have been in successful use as commercial calibrating standards, the author said. They have been used for calibrating instruments scaled in gage pressure, vacuum, absolute pressure, and differential pressure.

Experience has indicated a reproducibility of 0.005 psi., with errors in some cases up to 0.015 psi. Although its use at present is limited to those instruments where volumetric displacement is no handicap, Mr. Wood explained that improvements in this direction are now being studied with a solution to the problem being anticipated.

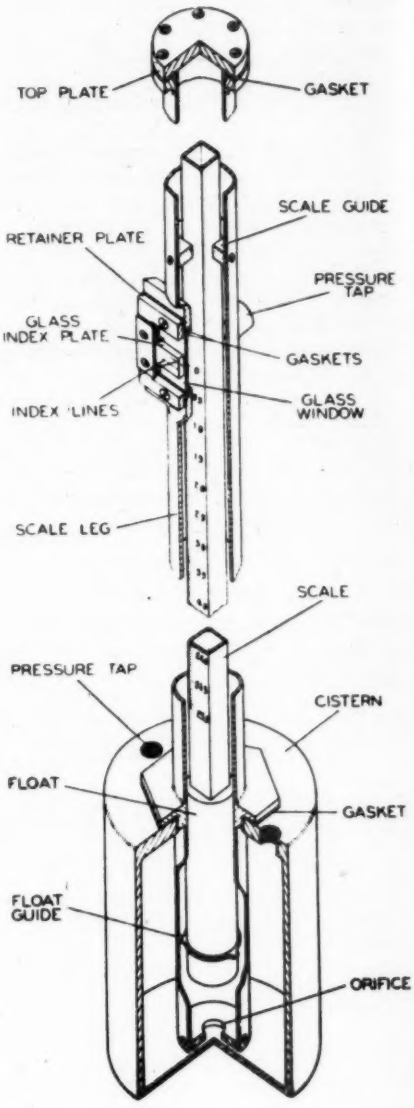

Fig. 2—Cutaway view of improved manometer for instrument calibration, featuring fixed index and floating scale in place of moving index and fixed scale of conventional models

Viscosity Control Has Applications In Manufacture of Lubricating Oils

"Application of Viscosity Measurement in Petroleum Refining Operations," by D. J. Pompeo, Head, Instrument and Glassblowing Department, Shell Development Co., Emeryville, California.

VISCOSITY takes an important role in the control of refining operations as applied to lubricating oils, fuel oils, Diesel fuels, jet fuels, and cutback asphalts.

For example, in a typical control laboratory as many as 300 determinations of viscosity are made per 24-hour period, Mr. Pompeo said. The bulk of these tests are made on lube oils, about 90%. He explained that temperature is the major factor in the running of these determinations. Blending of stocks is most often done to meet viscosity and viscosity index specifications.

The author stated that there is a definite need for instruments which will satisfactorily indicate or control viscosity. Except for one or two recent developments in this type of instrument, such devices are practically non-existent.

The places where automatic instruments are useful to the control of process variables such as viscosity were briefly summarized:

1. At the control house where lube oil fractions are obtained. At this point an accuracy of 1 to 2% is probably sufficient for the purpose because the oil requires further processing.

2. At solvent refining and dewaxing plants. In this case the measurement of viscosity index is important, and the viscosity measurement must be quite accurate to obtain a good value for the index. Indirect methods, such as continuous measurement of refractive index, may be used.

3. At the compound house where the lube oil is blended. Especially would this be important if continuous blending operations were developed because viscosity measurement would be required soon after the mixing took place.

4. At the pump houses where road oils are blended and asphalts are pumped to tank cars, trucks, or barges.

The author stated that progress will undoubtedly be made in these problems, not only by the instrument manufacturers, but also by the instrument development engineers of the oil companies as well.

What does the Man behind the wheel know... of the industry behind the pump?

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To the motorist, the familiar gasoline pump is a ready symbol of an industry known for its progressiveness, free competition and steadily decreasing prices. Surely, as he notes the current price per gallon, he must realize that—Federal and state taxes excluded—he is buying his 1947 gasoline for about half the price he paid for less efficient fuel in 1920.

But, how much does the man behind the wheel really know of the industry behind the pump?

Does he know that the petroleum industry has spent billions of dollars for exploration, development, transportation, marketing and distribution to bring the public better products at lower prices?

Does he realize that he is indebted to the petroleum industry for a major share in the development of those new, longer-wearing tires?

Is he aware that the gleaming plastics on his instrument panel were made possible by the lower-priced ethylene, phenol and other source materials developed by the petroleum industry?

Does he remember those trying, wartime days when the petroleum industry met every demand of America and its allies for high octane gasoline, superlative lubricating oils and source materials for explosives?

Has he even a vague idea of petroleum's latest miracles, and the important roles that petroleum derivatives are playing in literally dozens of industries?

Is he conscious of the human side of this great industry, pioneer in providing paid vacations, paid holidays, sickness and accident benefits?

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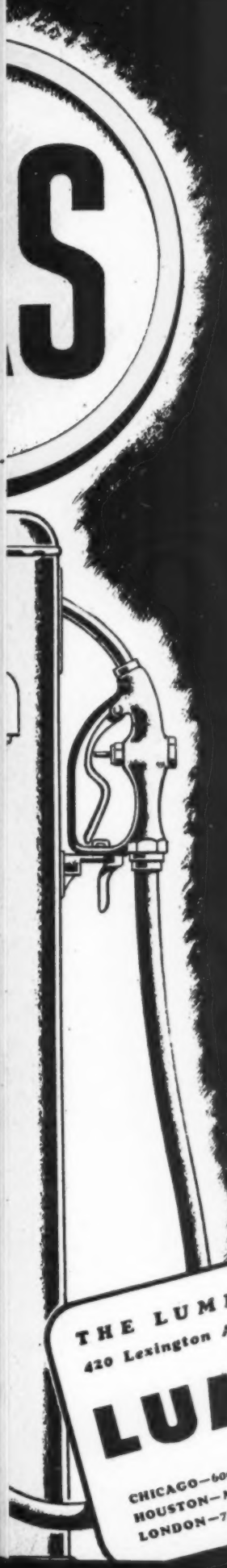

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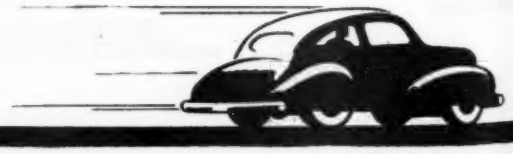

GAS OIL POLYFORMING

By W. C. OFFUTT, P. OSTERGAARD, M. C. FOGLE, H. BEUTHER

Presented before the 45th Annual Meeting, National Petroleum Association, Atlantic City, Sept. 18, 1947.
Messrs. Offutt, Fogle, and Beuther are with Gulf Research & Development Co.; Mr. Ostergaard is with the Process Engineering Department, Gulf Oil Corp.

A new development in the gas oil Polyform process calls for increasing the gas dilution to the range of 150-300 vol.%, with more severe cracking, to obtain improved yields of motor gasoline of high anti-knock quality and good sensitivity. The gas dilution is secured by recycling the gases made from cracking the oil, or outside C_3 and C_4 fractions can be utilized.

With high gas dilution, addition-type reactions take place between the gas and products from cracking the gas oil, and formation of coke is suppressed. Gas oil polyforming can also be operated to produce excess butane-butene when there is an overall deficiency of butane in the refinery. The Polyform process is a desirable means for converting refractory catalytic gas oils to gasoline, the gaseous by-products from catalytic cracking operations being converted to high yield of gasoline and at the same time supplying the gas dilution required with this type of charge stocks.

THE conventional thermal cracking of residual stocks and virgin gas oils is characterized by (1) high oil recycle ratios for maximum gasoline yield, (2) relatively low octane numbers of cracked gasoline, and (3) relatively high yields of tar. The octane level of gasoline obtained by thermal cracking of paraffinic stocks is generally in the range of 65 to 70 by the ASTM method, which is substantially lower than desired for blending to produce a satisfactory motor fuel for the highly competitive market.

Early units designed for polyforming of heavy petroleum fractions applied once-through cracking of reduced crudes and virgin gas oils with a moderate dilution of liquefied gas amounting to 40 to 75% based on oil charge. This operation was followed by cracking of the recycle stock with somewhat higher gas dilutions of the order of 75 to 100%. Furnace temperatures and pressures were not much higher than those used in conventional thermal cracking. The combination polyforming operation, however, improved the yield of gasoline slightly and raised the octane level to the range of 70 to 74 by the ASTM method for paraffinic stocks.

Further advances in the development of gas oil polyforming have recently been made, and attractive improvements have resulted. Operation of the gas oil Polyform process at a much greater severity of cracking and a high level of conversion in a single pass has been accomplished by increasing the gas dilution to the range of 150 to 300% by volume. Greatly improved yields of gasoline have been obtained on a once-through basis, and the anti-knock quality of the product from paraffinic virgin stocks has been raised to 73 to 77 by the ASTM method and 84 to 88 by the Research method without the addition of tetraethyl lead. The octane level is 76 to 82 by the ASTM method for Polyform gasolines produced from naphthenic virgin gas oils and light catalytic recycle stocks.

Use of Outside Gases Attractive

This new development in gas oil polyforming can be applied to the conversion of gas oil by itself, but it is especially attractive with the addition of outside C_3 and C_4 fractions. The conversion

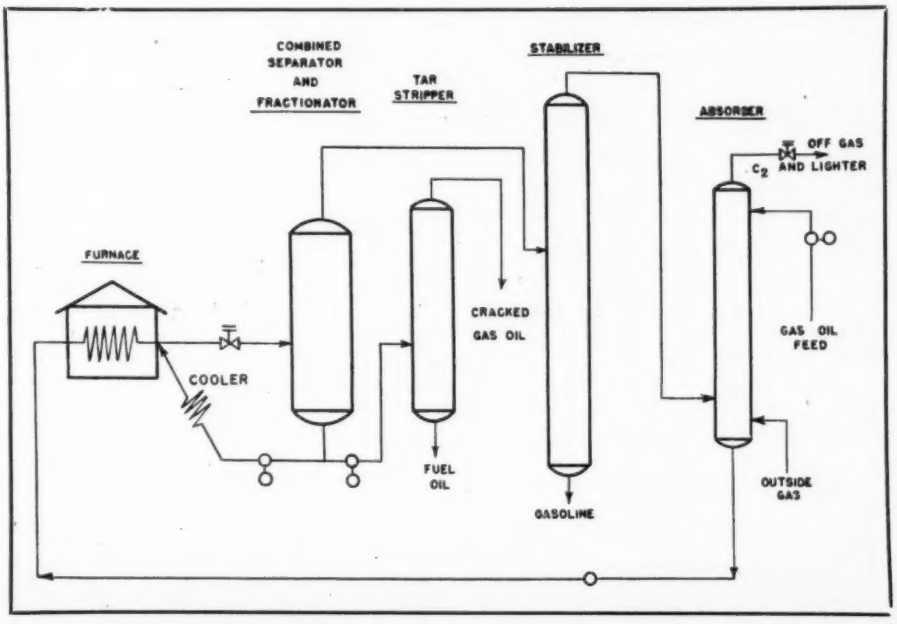

Fig. 1—Schematic flow sheet for single-pass gas oil polyforming

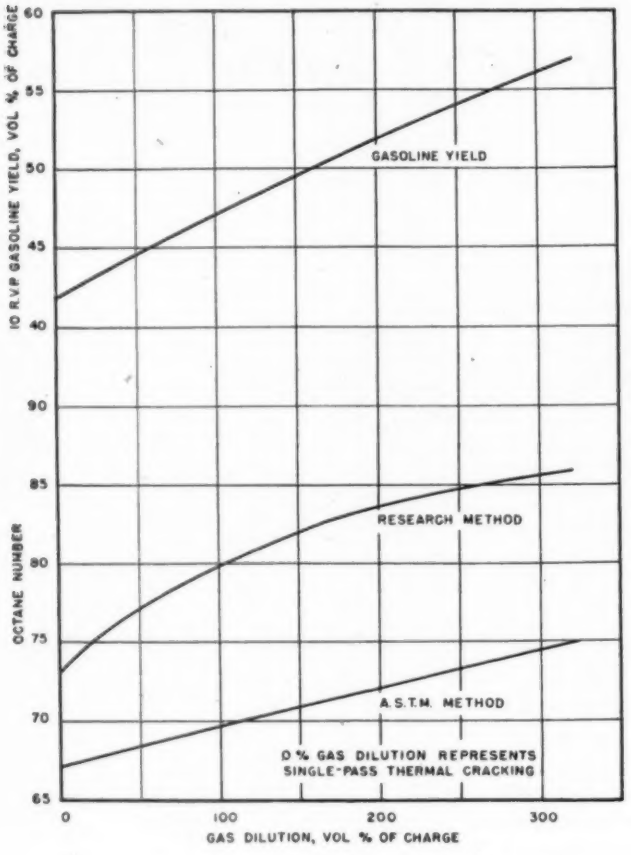
10 R.V.P GASOLINE YIELD, VOL % OF CHARGE
OCTANE NUMBER
GASOLINE YIELD
RESEARCH METHOD
A.S.T.M. METHOD
0 % GAS DILUTION REPRESENTS SINGLE-PASS THERMAL CRACKING
GAS DILUTION, VOL % OF CHARGE

Fig. 2 (LEFT) — Single-pass polyforming of a wide boiling range virgin gas oil

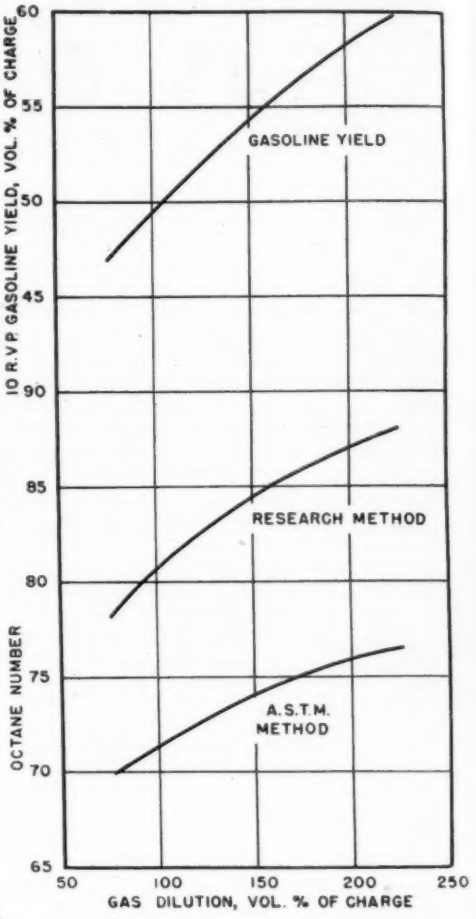

Fig. 3 (RIGHT)—Single-pass polyforming of a light virgin gas oil

of sizeable quantities of these hydrocarbons to gasoline can be accomplished without increasing the gas circulation above that required for polyforming of the gas oil at high severity without encountering coking trouble.

Gas oil polyforming at high gas dilution is carried out at cracking conditions comparable in severity to those used in naphtha polyforming. The cracking furnace is normally operated at outlet temperatures in the range of 1025 to 1100° F and at pressures of 1000 to 2000 psi. Single-pass conversions to lighter products are generally in the order of 60 to 70%.

The products from polyforming of gas oils consist of a stabilized gasoline distillate, a cracked gas oil fraction, a fuel oil of low gravity, and a fuel gas containing C_2 and lighter hydrocarbons. The cracked gas oil, which is a light fraction boiling between 400 and 600° F, is characterized by a low gravity, low aniline point, and low pour point. It is suitable as a cutting oil for heavy residues. From a cracking standpoint, it is a very exhausted stock which, if recracked, produces a comparatively low yield of gasoline.

Flow Through Polyform Process

Fig. 1 is a simplified flow sheet for once-through gas oil polyforming which is almost identical to naphtha polyforming in method of operation. Gas oil is charged to the top of a high-pressure absorber in which it absorbs a recycle gas consisting of small concentrations of C_2 hydrocarbons, virtually all C_3 hydrocarbons, and the butane-butene in excess of that required to maintain the desired vapor pressure of the Polyform gasoline. The rich gas oil is pumped from the base of the absorber through heat exchangers to the Polyform furnace. When outside gas is charged, it usually enters the system at the absorber.

The effluent from the furnace is quenched and then flashed into a separator which removes tar and gas oil as bottoms. The tar is stripped to fuel oil specifications, and cracked gas oil is removed from the top of the tar stripper. The separator overhead passes to the stabilizer where the gasoline is stabilized, and the overhead gases from the stabilizer are passed into the base of the absorber. The gasoline can be stabilized in either of two ways: (1) to produce a maximum yield of gasoline by controlling the volatility to approximately 10 Reid vapor pressure and recycling excess C_4 hydrocarbons, or (2) to recover a maximum yield of butane-butene containing a high concentration of olefins in addition to debutanized gasoline.

The latter method of operation is accomplished by depropanizing the gasoline in the stabilizer and recycling a minimum quantity of C_4 hydrocarbons. Essentially all of the C_3 and C_4 hydrocarbons in the overhead gases from the stabilizer are absorbed by the gas oil charge and recycled through the cracking furnace, while the C_2 and lighter gases leave the unit at the top of the absorber.

Effect of Gas Dilution

The presence of gas in the cracking furnace is the factor which permits gas oil polyforming operations to be performed at a sufficient degree of severity to obtain high single-pass conversions and high yields of gasoline having high-octane quality. Earlier studies of gas reactions and reactions of gas with products from naphtha cracking* showed that gas (C_3 and C_4 hydrocarbons) suppressed tar and coke formation by reacting with some of the products from naphtha cracking which ordinarily are subject to interreaction to form tar and coke. It was found that lower tar yields were produced from naphtha when it was reformed in a high dilution of gas.

The same types of reactions between gas and products of cracking occur in gas oil polyforming. Gas oils which tend to form coke at moderate conversions without the benefit of gas dilution yield higher and higher percentages of gasoline in one-pass operations when cracked in increasing gas dilutions.

While the gas dilution for gas oil

*"Naphtha Polyforming", by W. C. Offutt, P. Ostergaard, M. C. Fogle, and H. Buether, presented at the Group Session on Refining of the Twenty-sixth Annual Meeting of The American Petroleum Institute (1946). Petroleum Processing, December, 1946, pg. 267.

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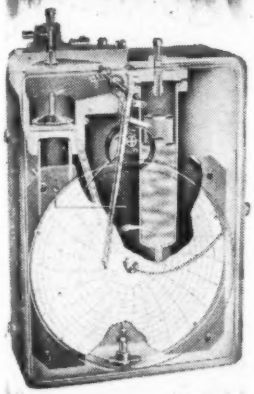

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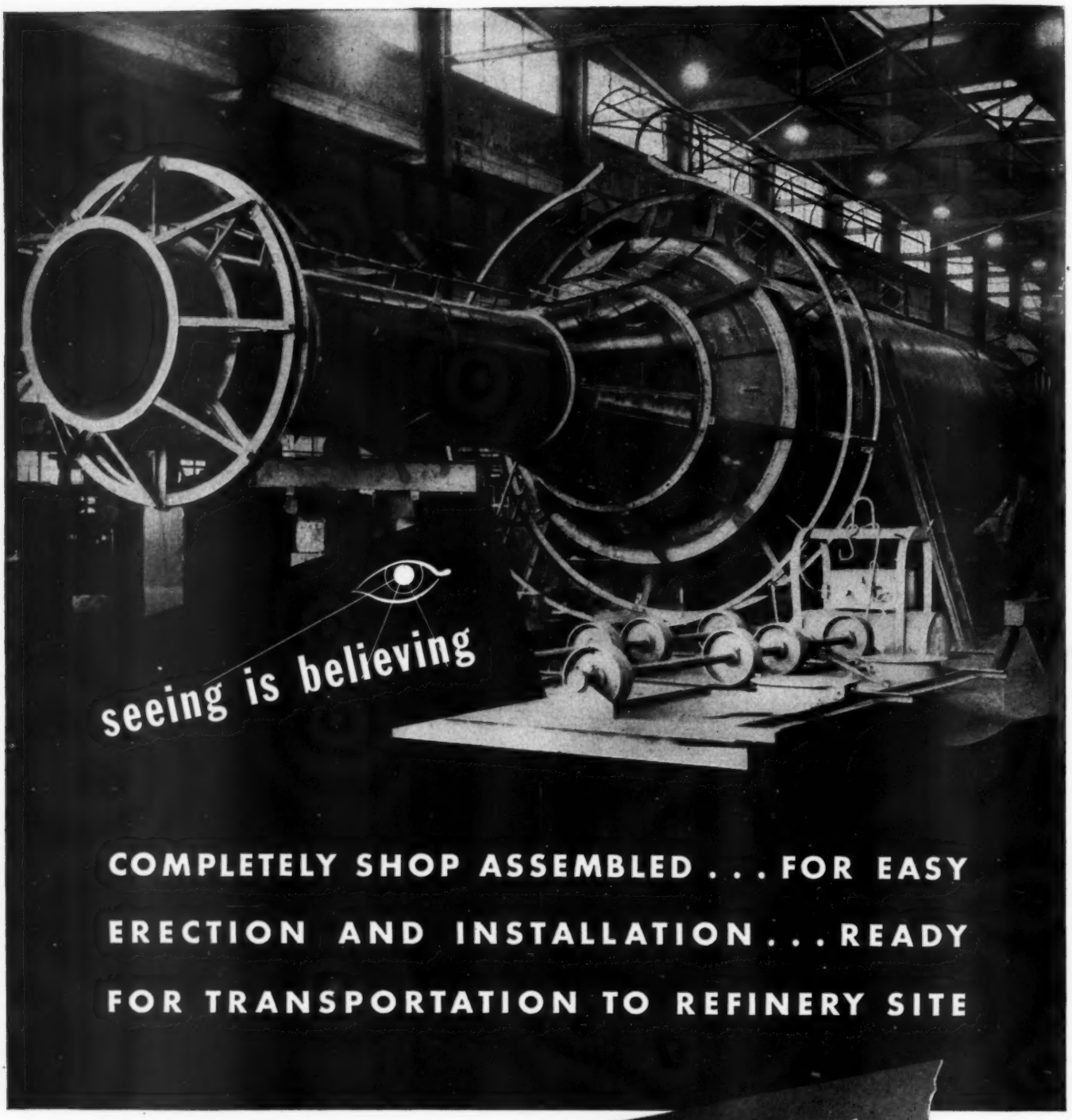

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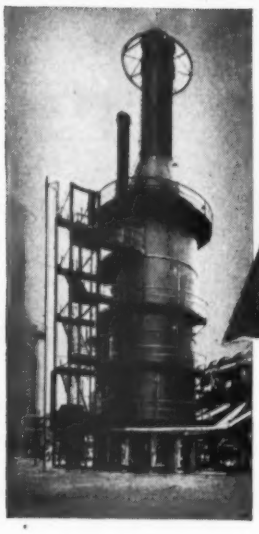

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polyforming on a volume percent basis is in the range of 150 to 300 vol.-% of gas oil charge, the ratio of mols of gas to mols of gas oil is much higher. Products from the cracking of the oil, therefore, are formed in an atmosphere of reactable gas, and there is a tendency to promote thermal alkylation, thermal polymerization, and other addition-type reactions between the gas and the reactive products made from cracking of the gas oil.

If gasolines with fairly high octane numbers are desired from wide boiling-range gas oils, it is necessary to maintain a sufficient gas dilution to permit a high cracking severity. At low gas dilutions, the maximum severity of cracking (as limited by coking) is only moderate, and the results show low yields and octane numbers from single-pass operation. Cracking severities may be increased at higher gas dilutions with the result that higher conversions, better gasoline yields, and higher octane numbers are obtained.

Fig. 2 is a plot of gas dilution versus octane numbers and yields for a 900° F end point wide boiling-range gas oil. when severity was held near the maximum level with respect to essentially coke-free operation. By increasing the gas dilution from 0 to 300%, the once-through gasoline yield increased from 42 to 56 vol-% while the ASTM octane number increased from 67.0 to 74.5 and the Research octane number from 73.3 to 85.6.

Fig. 3 shows a similarly large increase in yield and octane number by increasing the gas dilution when a light gas oil was polyformed. In this case, a narrower range of gas dilutions was covered (75 to 200 vol.-%). It can be seen for both stocks that there is a minimum gas dilution for satisfactory operation at a given octane level.

The maximum gas dilution that can be obtained without the use of outside gases depends upon the boiling range and characterization factor of the stock. Wide boiling-range virgin gas oils produce a sufficient quantity of C_3 hydrocarbons in the cracking process to allow a maximum gas dilution of approximately 300 vol.-%. Light virgin gas oils and light catalytic cycle stocks produce only enough recycle gas to permit a maximum of about 200% gas dilution. Some very refractory cycle stocks make even less gas, and the maximum gas dilution obtainable with no outside gas is 150 to 175 vol.-%. In all cases, the gas dilution can be raised by the addition of outside gas, or the gas dilution can be lowered by adjusting the operation of the absorber. The principal requirement is that the gas dilutions be high enough to obtain the desired cracking severity, conversion, or octane level without the excessive formation of coke.

TABLE 1—Single-Pass Polyforming of Virgin Gas Oils

Charge Stock	Wide Cut Naphtha	Kerosene	Light Gas Oil	Wide-Range Gas Oil
Operating Conditions				
Furnace Temperature, °F.	1085	1060	1070	1050
Furnace Pressure, lbs./sq. in.	1500	1500	1500	1500
Gas Dilution, vol. % of gas oil chg.	150	198	204	287
Yields, vol. % of gas oil charge				
Gasoline (10 R.V.P.)	68.6	64.0	58.7	55.8
Gas Oil (400-600° F., Approx.)	17.0	26.2	21.7	21.0
Fuel Oil (200 S.F.S. at 122° F., Approx.)			11.9	18.6
Inspections				
Charge Stock				
Gravity, °A.P.I.	47.2	43.0	35.6	30.9
Aniline Point, °F.	142	149	169	170
A.S.T.M. Distillation, °F.				(Vacuum)
I.B.P.	222	299	420	285
10%	307	367	496	505
50%	384	431	552	655
90%	468	487	629	861
E.P.	508	520	675	...
Characterization Factor	11.93	11.85	11.87	11.91
Products				
10 R.V.P. Gasoline				
Gravity, °A.P.I.	54.8	56.5	60.1	60.9
Bromine Number	65	69	87	89
Aniline Point, °F.	71	73	77	80
A.S.T.M. Distillation, °F.			*	
I.B.P.	97	108	106	102
10%	135	133	124	129
50%	238	218	201	227
90%	360	355	348	368
E.P.	393	401	390	394
Octane Numbers				
A.S.T.M., clear	76.3	76.3	76.0	74.4
A.S.T.M., +3 cc. T.E.L.	83.3	83.5	81.9	81.4
Research, clear	87.6	87.6	87.3	85.8
Research, +3 cc. T.E.L.	95.6	95.8	95.1	93.7
Gas Oil				
Gravity, °A.P.I.	...	...	24.3	24.2
Viscosity, S.U.S. at 100° F.	...	...	35	36
Pour Point, °F.	...	...	—40	—35
Aniline Point, °F.	...	...	81	78
A.S.T.M. Distillation, °F.				
I.B.P.	...	...	398	421
10%	...	...	472	459
50%	...	...	498	499
90%	...	...	550	570
E.P.	...	...	582	598
Fuel Oil	*	*		
Gravity, °A.P.I.	13.6	19.0	4.8	5.1
Viscosity, S.F.S. at 122° F.	...	...	195	191
Pour Point, °F.	<—70	<—70	35	30

*Fuel Oil Plus Gas Oil

TABLE 2—Properties of Cycle Stocks from Single-Pass Polyforming of Virgin Gas Oils

Charge Stock	Light Gas Oil	Wide-Range Gas Oil
Inspection of Gas Oil Charge		
Gravity, °A.P.I.	35.6	30.9
Viscosity, S.U.S. at 100° F.	40	53
Pour Point, °F.	15	60
Aniline Point, °F.	169	170
Characterization Factor	11.87	11.91
50% Point, A.S.T.M. Dist., °F.	552	655
Yield Cycle Stock, vol-% charge	21.7	21.0
Inspections of Cycle Stock		
Gravity, °A.P.I.	24.3	24.2
Viscosity, S.U.S. at 100° F.	35	36
Aniline Point, °F.	81	78
Characterization Factor	10.9	10.9
A.S.T.M. Distillation, °F.		
I.B.P.	398	421
10%	472	459
50%	498	499
90%	550	570
E.P.	582	598

Effect of Boiling Range

Single-pass polyforming of paraffinic virgin gas oils produces high yields of gasoline with ASTM clear octane numbers in the range of 74 to 77, and Research octane numbers in the range of 85 to 88. Naphthenic virgin gas oils produce gasolines with still higher octane numbers, but with slightly lower yields. Yields, octane numbers, and circulations differ with boiling range of the charge. Table 1 shows results from single-pass

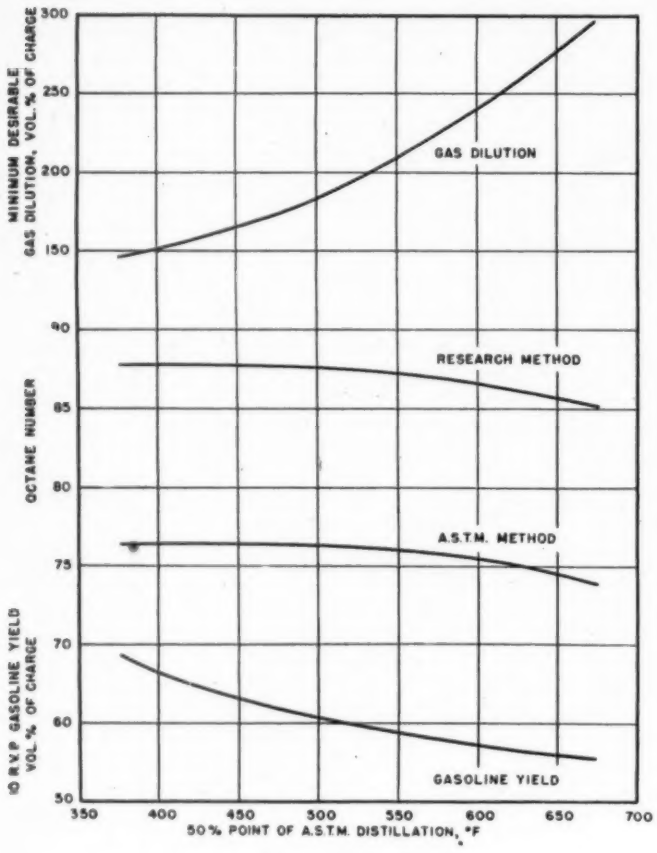

Fig. 4—Single-pass polyforming of virgin gas oils—effect of boiling range on yields, octane numbers, and minimum desirable gas circulation

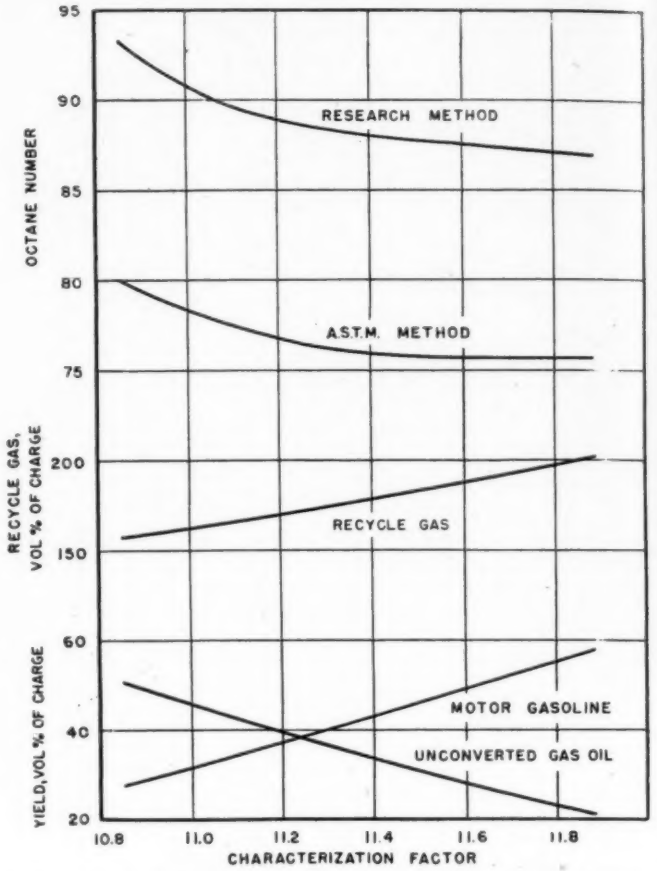

Fig. 5—Single-pass polyforming of 400-650° F. gas oils—effect of characterization factor on yields of gasoline and unconverted gas oil, gas dilution, and octane numbers of distillate

polyforming of several boiling-range virgin stocks from paraffinic crude sources.

This table indicates the extent to which yields and octane numbers are functions of the boiling range of the charge stock. The gas circulation was set at approximately the minimum to permit a sufficiently severe operation for the production of a high-octane gasoline. Fig. 4 illustrates graphically the effect of the 50% point of the gas oil charge on yields, octane numbers, and minimum desirable gas circulation for gas oils with a characterization factor of about 11.9.

Lighter gas oils produce more gasoline with higher octane numbers and require lower gas circulations than heavier charge stocks. Heavy distillate oils can be polyformed satisfactorily, although the maximum octane number is limited on heavy stocks.

The unconverted oil or cycle stock is similar to cycle stocks obtained from catalytic cracking. The yield and quality of the cycle stock produced from single-pass polyforming does not vary greatly with boiling range of the charge. The cycle stock produced depends more upon the character of the charge and polyforming severity rather than the boiling range of the charge. Table 2 shows yields and properties of cycle stocks from the polyforming of light and wide boiling-range gas oils. These oils are excellent cutting oils for heavy residues. They are poor cracking stocks, which when cracked thermally, produce a low yield of high-octane gasoline.

Effect of Outside Gas

When gas oils are polyformed with no outside gas, the gas dilution necessary for severe cracking of the gas oil consists of gases made from cracking of the oil. As the gas dilution is increased, more complete retention of C_3 hydrocarbons in the recycle gas is obtained, and the gas recycle stream becomes more lean in olefin. The amount of gas that is converted each pass decreases, and the conversion per pass of gas to gasoline is relatively small. When outside gases such as olefinic C_3 fractions or butane-butene are charged, the circulating gas becomes more olefinic and less refractory and thus serves two functions: (1) to permit high cracking severities on the gas oil and (2) to utilize the required gas dilution to produce attractive yields of gasoline from extraneous gas. In some cases, as much as 25% of olefinic outside gas based on oil charge can be converted with no increase in gas circulation. In a situation of this type, the additional cost of processing the gas is very low.

There are some situations where small increases in gas dilution are necessary if it is desired to convert a given amount of outside gas. Table 3 shows examples of single-pass polyforming of a wide boiling-range and a light virgin gas oil in a self-contained operation and with various types of outside gases for comparison. In one case where 17 vol.-% of outside propane-propylene containing 60% of olefin was charged with a wide boiling-range gas oil, an increase in gasoline yield of 11.3% was obtained. The additional yield of gasoline, amounting to 66.5 vol.-% of the gas charge, was realized with no increase in gas circulation. When 21 vol.-% of n-butane was charged as outside gas, a yield of 35 vol.-% of gasoline was obtained from the gas with no increase in gas circulation.

For stocks ordinarily requiring low gas dilutions, it is generally necessary to increase the circulation in order to convert an appreciable amount of outside gas. When polyforming a light virgin gas oil (440 to 700° F) which generally requires a gas dilution of about 200%, the gas circulation must be increased to about 275% to convert 20 to 25% of out-

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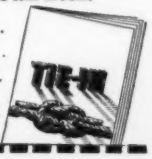

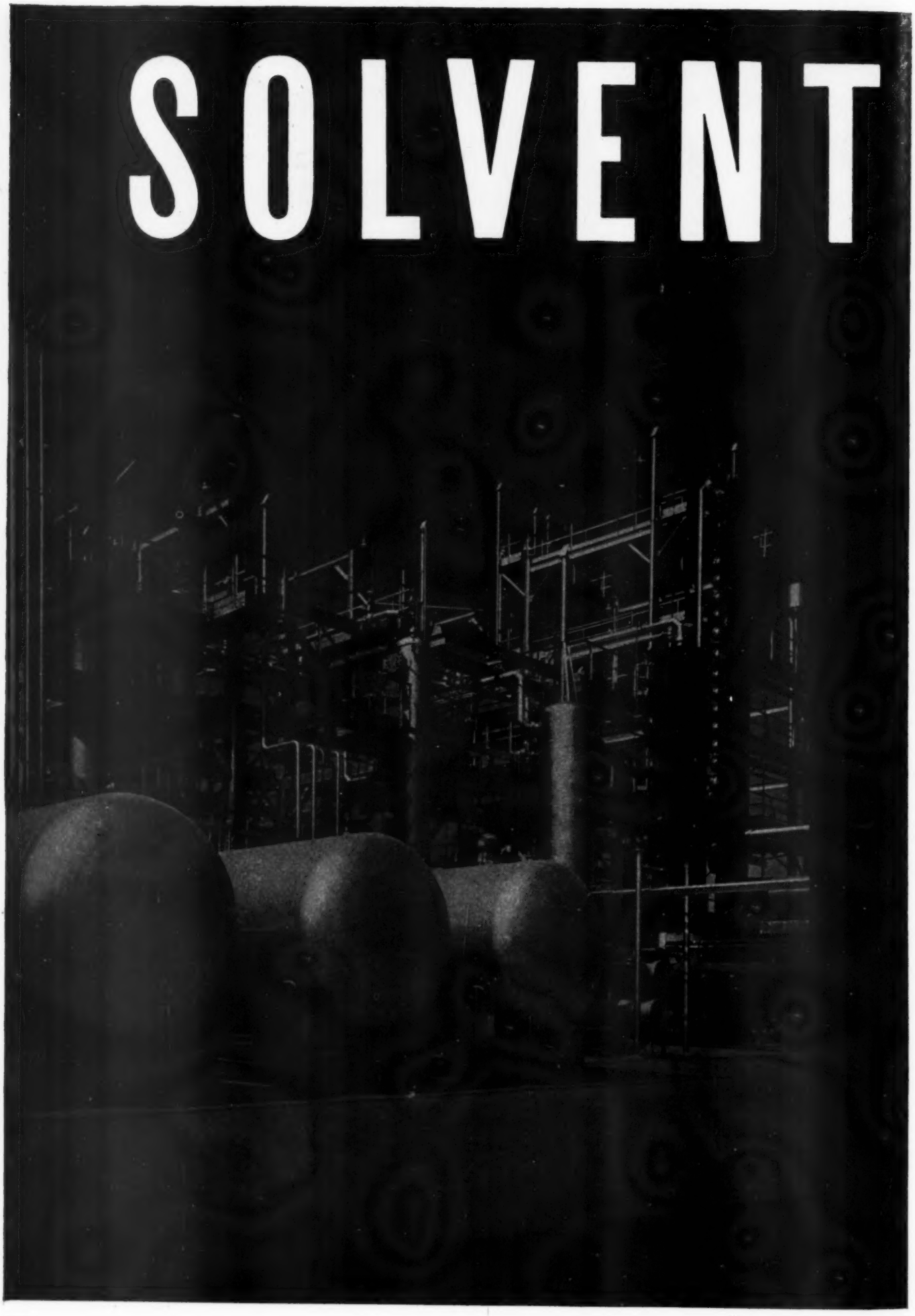
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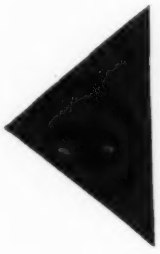

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side propane-propylene, outside butane-butene, or outside n-butane. Twenty percent of propane-propylene containing 60% of olefin increased the gasoline yield from 58.7 to 67.2. The increase in gasoline yield was 42.5 vol.-% based on the outside gas. Similar yields were obtained from butane-butene.

Operation for Maximum Butane-Butene Production

Operation of the gas oil Polyform unit can be varied to compensate for changing butane requirements in the refinery. When excess butane-butene is available, it can be used as an outside gas charge to the Polyform unit and converted to gasoline. If the rest of the refinery has a good butane balance, the Polyform unit can be operated to produce only enough butane for vapor pressure requirements of the gasoline. However, the Polyform unit can also be used to produce excess butane-butene when there is an overall deficiency of butane in the refinery. This latter type of operation requires only a change in the method of operating the stabilizer.

Table 4 shows a typical operation for the production of maximum butane-butene from a light virgin gas oil compared to normal operation for gasoline having a Reid vapor pressure of 10. Since essentially all of the butane-butene was removed from the gas recycle stream in the operation for maximum butane-butene production, it was necessary to charge 6% of outside propane to maintain the desired gas dilution.

This operation produced a yield of 10% of excess butane-butene containing 52% of unsaturates, and there was a decrease of 3.7% in the yield of 10 RVP motor gasoline. A total yield of gasoline plus butane-butene of 60.0% was obtained in the operation for maximum gasoline production, while a yield of 65.0% was obtained when operating for maximum butane-butene production with 6% of outside propane.

Comparison of Single-Pass Polyforming With Recycle Thermal Cracking

Single-pass polyforming was compared with single-pass thermal cracking of the same stock in Fig. 2 (0% gas dilution representing thermal cracking). This was not a desirable comparison of the two processes because it was necessary to conduct the thermal cracking operations at a low degree of conversion due to coking limitations. Since it is also common practice to recycle the unconverted gas oil in thermal cracking, this type of operation provides a more satisfactory basis for evaluating single-pass polyforming.

Table 5 presents a comparison between single-pass polyforming and recycle thermal cracking for two similar light paraffinic gas oils. It is interesting to note that the quantity of oil recycled

TABLE 3—Single-Pass Polyforming of Virgin Gas Oils With and Without Outside Gas

Charge Stock	Light Gas Oil			Wide-Range Gas Oil		
Outside Gas Charge	None	Propane-Propylene	Butane-Butene	None	Propane-Propylene	N-Butane
Unsaturates, vol.-%	...	60	50	...	60	0
Operating Conditions						
Furnace Outlet Temperature, °F.	1070	1070	1070	1050	1060	1040
Furnace Pressure, lbs./sq. in.	1500	1500	1500	1500	1500	1500
Gas Dilution, vol.-% of gas oil charge	204	295	294	287	303	310
Outside Gas, vol.-% of gas oil charge	0	20	18	0	17	21
Yields, vol.-% of gas oil charge						
Gasoline (10 R.V.P.)	58.7	67.2	67.5	55.8	67.1	63.2
Gas Oil (400-600° F., Approx.)	21.7	19.6	21.0	21.0	19.7	22.8
Fuel Oil (200 S.F.S. at 122° F., Approx.)	11.9	13.7	13.8	18.6	17.4	20.5
Inspections						
Charge Stock						
Gravity, °A.P.I.	35.6	35.6	34.3	30.9	32.7	30.9
Aniline Point, °F.	169	169	172	170	171	170
A.S.T.M. Distillation, °F.				(Vacuum)	(Vacuum)	(Vacuum)
I.B.P.	420	420	423	285	300	285
10%	496	496	510	505	516	505
50%	552	552	565	655	641	655
90%	629	629	689	861	773	861
E.P.	675	675	736	...	...	...
Characterization Factor	11.87	11.87	11.86	11.91	11.97	11.91
Products						
10 R.V.P. Gasoline						
Gravity, °A.P.I.	60.1	60.5	59.3	60.9	62.0	61.9
Bromine Number	87	...	93	89	83	62
Aniline Point, °F.	77	85	74	80	85	90
A.S.T.M. Distillation, °F.						
I.B.P.	106	98	106	102	92	101
10%	124	134	130	129	115	129
50%	201	204	205	227	197	200
90%	348	336	357	368	356	339
E.P.	390	394	410	394	400	399
Octane Numbers						
A.S.T.M., clear	76.0	75.5	75.8	74.4	74.2	74.6
A.S.T.M., +3 cc. T.E.L.	81.9	83.2	82.4	81.4	...	82.4
Research, clear	87.3	86.1	89.0	85.8	85.2	84.4
Research, +3 cc. T.E.L.	95.1	95.1	96.6	93.7	93.6	93.4
Gas Oil						
Gravity, °A.P.I.	24.3	21.3	22.6	24.2	23.6	24.2
Viscosity, S.U.S. at 100° F.	35	36	37	36	37	36
Pour Point, °F.	−40	−40	−60	−35	−35	−30
Aniline Point, °F.	81	...	82	78	83	89
A.S.T.M. Distillation, °F.						
I.B.P.	398	444	470	421	456	437
10%	472	472	494	459	490	464
50%	498	523	518	499	520	510
90%	550	640	568	570	590	578
E.P.	582	685	610	598	638	623
Fuel Oil						
Gravity, °A.P.I.	4.8	...	5.6	5.1	5.1	5.6
Viscosity, S.F.S. at 122° F.	195	...	187	191	169	171
Pour Point, °F.	35	...	20	30	25	30

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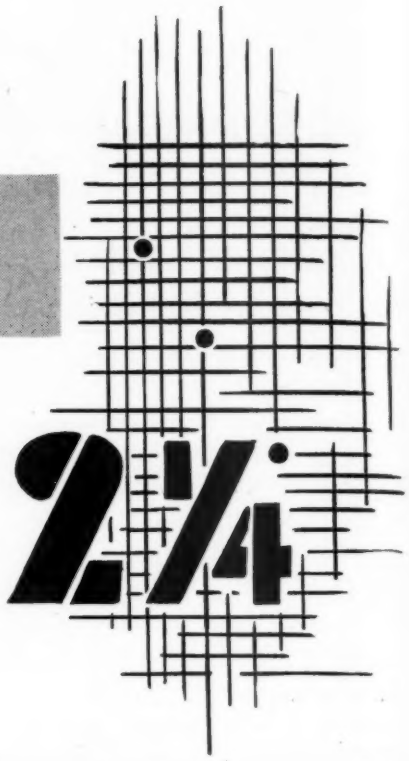

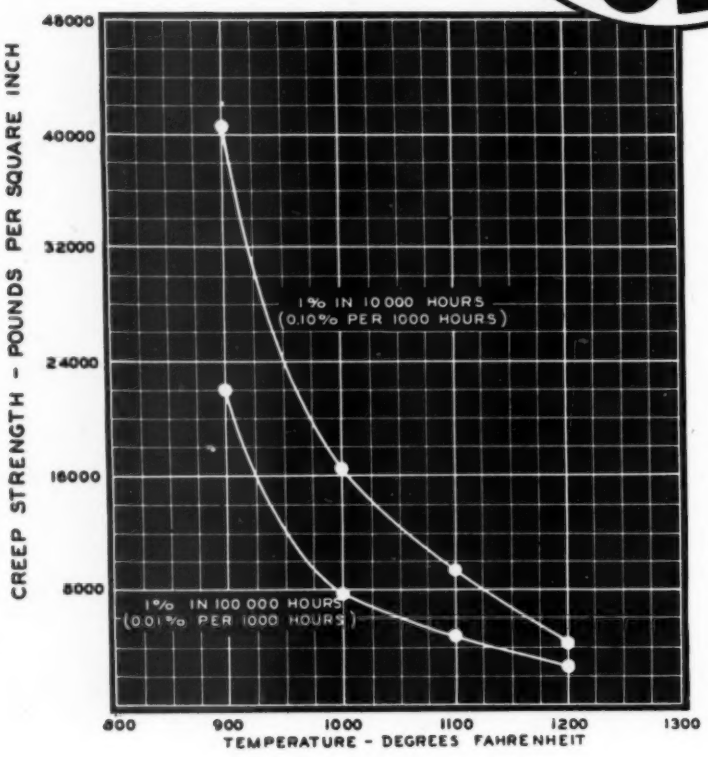

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in the thermal cracking operation is in the same order of magnitude as the gas dilution required for the polyforming operation. The two methods of operation are not directly comparable in some respects. The polyforming operation produced 21.7% of cracked gas oil in addition to the usual products obtained from thermal cracking. The recycle thermal cracking operation made 7.5% of excess butane-butene and 13.0% of a C_3 fraction which was relatively low in olefin content.

Although these basic differences exist in the by-products from the two processes, the yields of gasoline are almost identical. The principal advantage of the polyforming operation is in the quality of the gasoline. The unleaded ASTM and Research octane numbers of the Polyform distillate are 76.0 and 87.3, compared to 71.8 and 81.9 for the distillate from conventional thermal cracking. Additional advantage may be gained from the unconverted gas oil which can be recycled for further gasoline production or used as a cutting oil for blending with viscous residual stocks. This comparison at about the same yield of gasoline indicates that gas oil polyforming permits a substantially higher recovery of liquid products than the recycle thermal cracking operation.

The comparison shown in Table 5 involved a self-contained polyforming operation without outside gas charge. It has been previously mentioned that gas oil polyforming operations may be greatly enhanced by charging extraneous refinery gas streams with little or no additional processing cost. In this manner, further advantages with respect to gasoline production can be gained from the polyforming operation.

Polyforming of Catalytic Cycle Stocks

The increasing quantities of catalytic cycle stocks available for processing or handling in the modern refinery accentuates the importance of an efficient means of converting these stocks to high quality gasoline. The refractory nature of light catalytic cycle stocks makes recycling within the catalytic cracking unit, in most cases, an unadvisable operation, especially in a refinery where catalytic cracking capacity is limited or sufficient charge is available from virgin sources.

Conversion of cycle stocks to gasoline by conventional thermal cracking processes requires extensive recycling of gas oil for ultimate yield. This ultimate yield of gasoline, however, may be approached in a single pass by gas oil polyforming. A high percentage of gas

TABLE 4—Comparison of Maximum Butane-Butene Production with Maximum Gasoline Production for Single-Pass Polyforming of a Light Virgin Gas Oil

	Maximum Gasoline	Maximum Butane-Butene
Operating Conditions		
Furnace Outlet Temperature, °F.	1070	1070
Furnace Pressure, lbs./sq. in.	1500	1500
Gas Dilution, vol.-% of gas oil chg.	204	202
Outside Propane, vol.-% of gas oil chg.	0	6
Yields, vol.-% of gas oil charge		
Gasoline (10 R.V.P.)	58.7	55.0
Excess Butane-Butene	1.3	10.0
Total Butane-Butene	5.4	13.6
Gas Oil (400-600° F., Approx.)	21.7	19.5
Fuel Oil (200 S.F.S. at 122° F., Approx.)	11.9	12.0
Inspections		
Charge Stock		
Gravity, °A.P.I.	35.6	34.3
Aniline Point, °F.	169	172
A.S.T.M. Distillation, °F.		
I.B.P.	420	423
10%	496	510
50%	552	565
90%	629	689
E.P.	675	736
Characterization Factor	11.87	11.86
Products		
10 R.V.P. Gasoline		
Gravity, °A.P.I.	60.1	57.3
Bromine Number	87	76
Aniline Point, °F.	77	72
A.S.T.M. Distillation, °F.		
I.B.P.	106	102
10%	124	135
50%	201	210
90%	348	340
E.P.	390	396
Octane Numbers		
A.S.T.M., clear	76.0	75.8
A.S.T.M., +3 cc. T.E.L.	81.9	83.8
Research, clear	87.3	88.4
Research, +3 cc. T.E.L.	95.1	96.6
Gas Oil		
Gravity, °A.P.I.	24.3	22.0
Viscosity, S.U.S. at 100° F.	35	37
Pour Point, °F.	−40	−45
Aniline Point, °F.	81	73
A.S.T.M. Distillation, °F.		
I.B.P.	398	461
10%	472	483
50%	498	511
90%	550	568
E.P.	582	630
Fuel Oil		
Gravity, °A.P.I.	4.8	5.7
Viscosity, S.F.S. at 122° F.	195	195
Pour Point, °F.	35	35

TABLE 5—Comparison of Single-Pass Polyforming of a Light Gas Oil with Recycle Thermal Cracking

	Single-Pass Polyforming	Recycle Thermal Cracking
Operating Conditions		
Furnace Outlet Temperature, °F.	1070	1000
Furnace Pressure, lbs./sq. in.	1500	750
Gas Dilution, vol.-% of gas oil charge	204	...
Recycle Oil, vol.-% of gas oil charge	...	215
Yields, vol.-% of gas oil charge		
Gasoline (10 R.V.P.)	58.7	57.7
Gas Oil (400-600° F. Approx.)	21.7	...
Fuel Oil (200 S.F.S. at 122° F., Approx.)	11.9	24.4
Inspections		
Charge Stock		
Gravity, °A.P.I.	35.6	34.3
Aniline Point, °F.	169	172
A.S.T.M. Distillation, °F.		
I.B.P.	420	423
10%	496	510
50%	552	565
90%	629	689
E.P.	675	736
Characterization Factor	11.87	11.86
Products		
10 R.V.P. Gasoline		
Gravity, °A.P.I.	60.1	58.3
Bromine Number	87	76
Aniline Point, °F.	77	85
A.S.T.M. Distillation, °F.		
I.B.P.	106	92
10%	124	143
50%	201	238
90%	348	358
E.P.	390	411
Octane Numbers		
A.S.T.M., clear	76.0	71.8
A.S.T.M., +3 cc. T.E.L.	81.9	81.4
Research, clear	87.3	81.9
Research, +3 cc. T.E.L.	95.1	92.0
Gas Oil		
Gravity, °A.P.I.	24.3	...
Viscosity, S.U.S. at 100° F.	35	...
Aniline Point, °F.	81	...
A.S.T.M. Distillation, °F.		
I.B.P.	398	...
10%	472	...
50%	498	...
90%	550	...
E.P.	582	...
Fuel Oil		
Gravity, °A.P.I.	4.8	6.1
Viscosity, S.F.S. at 122° F.	195	84
Pour Point, °F.	35	45
B.S.&W., %	0.5	0.5

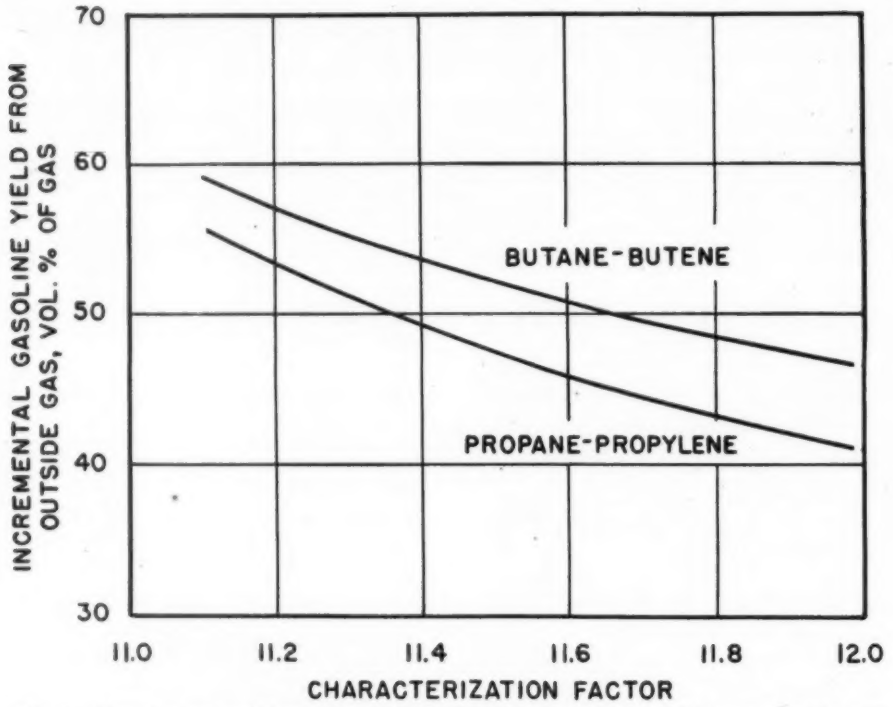

Fig. 6—Single-pass polyforming of light gas oils—gasoline yield from outside gas versus characterization factor

oil also remains unconverted in this operation, and this highly refractory oil may be subjected to further cracking or used for fuel oil blending. The gas dilutions necessary for severe conversion are moderate due to the inherent characteristics of the stocks.

Table 6 shows yields and octane quality of the gasoline obtained from self-contained polyforming of three light catalytic cycle stocks. The range of characteristics of these three stocks was caused by variations in severity of cracking and charge properties of the catalytic operations from which they were produced. The yields of gasoline and unconverted gas oil from the polyforming operations are very sensitive to the character of the cycle stock charged. There is also a substantial increase in octane numbers of the gasoline produced from the most refractory gas oil.

Fig. 5 pictures graphically the effect of characterization factor of the charge on yields of gasoline and unconverted gas oil, gas dilution, and octane number of distillate produced from single-pass polyforming of light catalytic cycle stocks. The curves were extended to a polyforming operation on a light virgin gas oil at the end of the scale representing high characterization factors. The operation on the virgin gas oil falls directly in line with those made on the catalytic cycle stocks.

Polyforming of Catalytic Cycle Stocks With Outside Gas

Extraneous C_3 and C_4 fractions derived from catalytic cracking or other refinery operations can be converted advantageously to gasoline in conjunction with polyforming light catalytic cycle stocks. Since the gas dilution for self-contained polyforming of catalytic gas oils is normally in the range of 150 to 185 vol.-%, it is often desirable to increase the gas circulation for operations charging substantial amounts of outside gas. Increasing the amount of gas dilution in this type of operation is optional, however, but less extensive conversion of the outside gas may be expected when the total gas circulation is limited.

Table 7 shows yields and octane numbers of the distillate from polyforming two light catalytic cycle stocks with outside normal butane and olefinic C_3 and C_4 fractions from catalytic cracking. Increased gas circulations in the range of 270 to 280 vol.-% were used in order to convert 20 to 25% (based on oil charge) of the various outside gas streams. The data indicate that approximately 4 to 5 passes were necessary to convert the outside gas completely.

Incremental yields of gasoline resulting from conversion of the extraneous gas were calculated to be 45 to 60 vol.-%, based on outside gas for the various operations. Fig. 6 shows a plot of incremental yields of gasoline as a function of characterization factor of

TABLE 6—Single-Pass Polyforming of Light Catalytic Cycle Stocks

Type of Charge to Catalytic Unit	Paraffinic	Intermediate	Naphthenic
Operating Conditions (Polyform Unit)			
Furnace Temperature, °F.	1070	1060	1070
Furnace Pressure, lbs./sq. in.	1500	1500	1500
Gas Dilution, vol.-% of gas oil charge	183	166	160
Yields, vol.-% of gas oil charge			
Gasoline (10 R.V.P.)	43.0	36.7	27.0
Gas Oil (400-600° F., Approx.)	33.2	41.3	53.0
Fuel Oil (200 S.F.S. at 122° F., Approx.)	14.9	15.0	10.4
Inspections			
Polyform Charge Stock			
Gravity, °A.P.I.	30.9	28.0	23.9
Aniline Point, °F.	133	110	96
A.S.T.M. Distillation, °F.			
I.B.P.	430	393	451
10%	482	461	477
50%	525	517	503
90%	602	581	555
E.P.	657	625	630
Characterization Factor	11.44	11.18	10.86
Products			
10 R V.P. Gasoline			
Gravity, °A.P.I.	61.0	58.5	...
Bromine Number	94	62	...
Aniline Point, °F.	75	73	...
A.S.T.M. Distillation, °F.			
I.B.P.	98	90	...
10%	120	121	...
50%	203	211	...
90%	350	360	...
E.P.	397	401	...
Octane Numbers			
A.S.T.M., clear	76.2	75.9	79.9
A.S.T.M., +3 cc. T.E.L.	83.0	82.7	85.8
Research, clear	88.0	86.9	93.2
Research, +3 cc. T.E.L.	95.8	94.6	99.5
Gas Oil			
Gravity, °A.P.I.	20.3	17.2	...
Viscosity, S.U.S. at 100° F.	35	35	...
Pour Point, °F.	−40	−30	...
Aniline Point, °F.	101	86	...
A.S.T.M. Distillation, °F.			
I.B.P.	441	445	...
10%	466	474	...
50%	501	507	...
90%	556	564	...
E.P.	619	601	...
Fuel Oil			
Gravity, °A.P.I.	1.2	0.9	...
Viscosity, S.F.S. at 122° F.	85	198	...
Pour Point, °F.	30	40	...
B.S.&W., %	Trace	0.1	...

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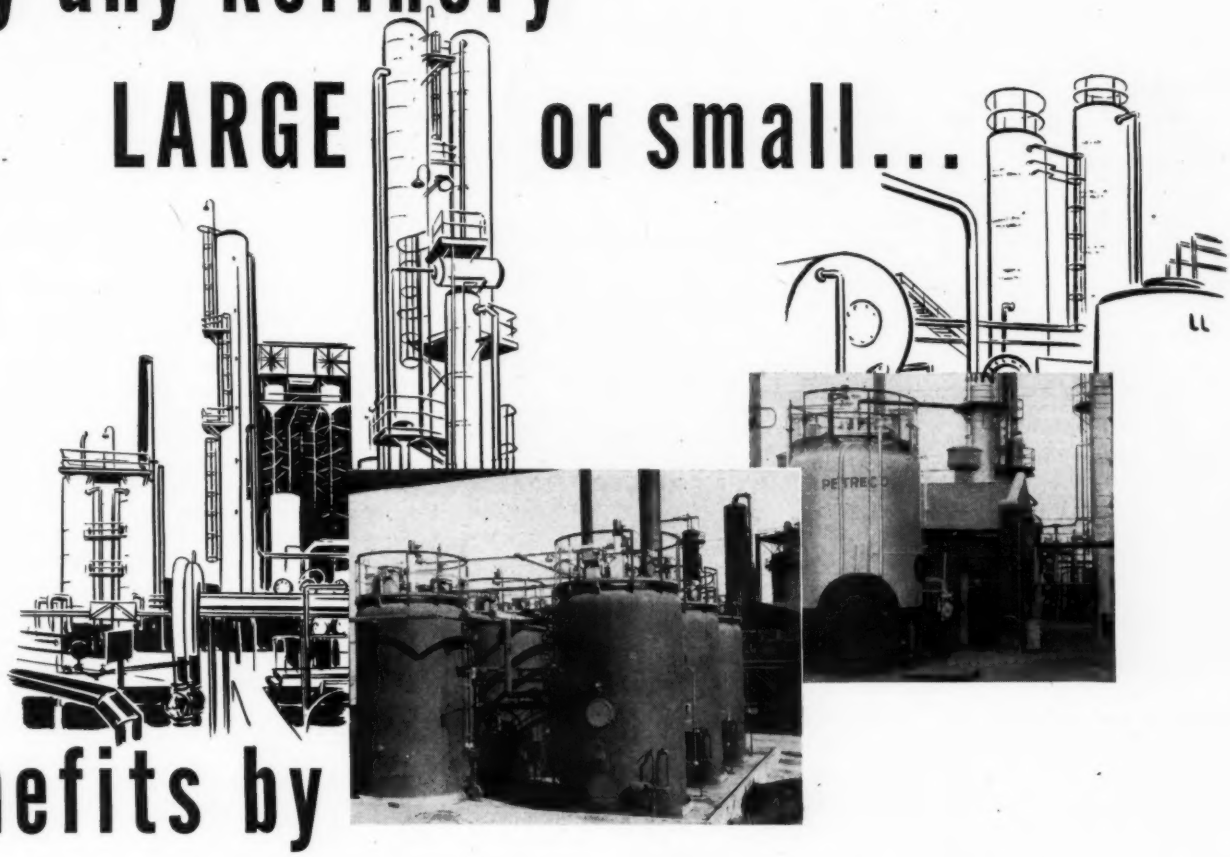

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the gas oil charged to the Polyform unit. This plot was constructed from data for the two light catalytic cycle stocks and a light virgin gas oil from a paraffinic crude. Although incremental yields are subject to considerable error due to the manner in which they must be calculated, there are certain trends which seem to apply. Outside butane-butene produces somewhat higher yields of gasoline with each gas oil than those obtained from an olefinic C_3 fraction. It also appears that higher incremental yields are realized from either gas fraction when gas oils having lower characterization factors are polyformed.

Conclusion

The extreme degree of cracking severity which it is possible to attain in a polyforming furnace makes the Polyform process a highly desirable means of converting refractory catalytic gas oils to gasoline. The severe cracking is accomplished by means of a moderately high gas dilution which can also be utilized as the necessary circulation for converting partially or completely the gaseous by-products from catalytic cracking operations. Attractive yields of gasoline are obtained from the extraneous gas, as well as from the gas oil charged.

Polyforming also offers many important advantages in gasoline production for the processing of crude fractions which are least desirable as charge stocks for catalytic cracking. Straight-run gasolines, naphthas, and light virgin gas oils are readily converted to high yields of quality blending components for motor gasoline. A wide degree of flexibility of operation can be maintained since the equipment and range of processing variables are essentially the same for all of the various types of charge. Compensations for seasonal variations in the requirements for light fuel oils and butane-butene can also be made by simple adjustments in the operation of the Polyform unit. In this manner, the Polyform process can serve as a complementary process with catalytic cracking as a means for attaining the ultimate yield of quality gasoline from a given quantity of crude.

The high level of the laboratory octane ratings of gasolines from gas oil polyforming has been emphasized throughout the foregoing discussion. Road performance of these gasolines also indicates especially good quality at all engine speeds and good road lead susceptibility. Chemical analysis of Polyform gasolines shows favorable distribution of hydrocarbon types throughout the boiling range. This feature, together with balanced volatility, confirms the desirable blending properties offered by distillates from the Polyform process.

TABLE 7—Single-Pass Polyforming of Light Catalytic Cycle Stocks with Outside Gases

Type of Charge to Catalytic Unit	Paraffinic			Intermediate			
Outside Gas Charge	None	Propane-Propylene	Butane-Butene	None	Propane Propylene	N-Butane	Butane-Butene
Unsaturates, vol.-%	...	60	50	...	60	0	50
Operating Conditions (Polyform Unit)							
Furnace Outlet Temperature, °F.	1070	1070	1070	1060	1070	1070	1080
Furnace Pressure, lbs./sq. in.	1500	1500	1500	1500	1500	1500	1500
Gas Dilution, vol.-% of gas oil chg.	183	303	298	166	295	301	296
Outside Gas, vol.-% of gas oil charge	0	25	20	0	25	25	20
Yields, vol.-% of gas oil charge							
Gasoline (10 R.V.P.)	43.0	55.1	57.3	36.7	50.2	46.7	48.0
Gas Oil (400-600° F., Approx.)	33.2	35.6	35.1	41.3	37.6	43.2	35.8
Fuel Oil (200 S.F.S. at 122° F., Approx.)	14.9	15.1	13.2	15.0	17.0	14.5	17.6
Inspections							
A.S.T.M. Distillation, °F.							
Charge Stock	30.9	30.9	30.9	28.0	28.0	28.0	28.0
Gravity, °A.P.I.	133	133	133	110	110	110	110
Aniline Point, °F.							
I.B.P.	430	430	430	393	393	393	393
10%	482	482	482	461	461	461	461
50%	525	525	525	517	517	517	517
90%	602	602	602	581	581	581	581
E.P.	657	657	657	625	625	625	625
Characterization Factor	11.44	11.44	11.44	11.18	11.18	11.18	11.18
Products							
10 R.V.P. Gasoline							
Gravity, °A.P.I.	61.0	61.2	60.5	58.5	60.5	63.6	58.4
Bromine Number	94	78	88	62	77	70	69
Aniline Point, °F.	75	80	79	73	75	83	70
A.S.T.M. Distillation, °F.							
I.B.P.	98	91	92	90	94	96	97
10%	120	117	117	121	117	111	124
50%	203	192	193	211	188	193	202
90%	350	342	348	360	359	358	367
E.P.	397	399	400	401	400	396	402
Octane Numbers							
A.S.T.M., clear	76.2	76.0	76.2	75.9	77.1	76.5	77.5
A.S.T.M., +3 cc. T.E.L.	83.0	84.1	83.3	82.7	83.7	84.1	84.3
Research, Clear	88.0	87.2	87.9	86.9	88.2	88.1	90.3
Research, +3 cc. T.E.L.	95.8	95.2	95.8	94.6	96.0	95.5	97.1
Gas Oil							
Gravity, °A.P.I.	20.3	19.6	19.3	17.2	17.1	18.0	14.9
Viscosity, S.U.S. at 100° F.	35	36	36	35	35	35	35
Pour Point, °F.	−40	−45	−40	−30	−65	−50	<−70
Aniline Point, °F.	101	...	101	86	86	87	74
A.S.T.M. Distillation, °F.							
I.B.P.	441	441	456	445	...	350	454
10%	466	473	482	474	470	467	475
50%	501	508	511	507	500	508	506
90%	556	569	577	564	548	570	569
E.P.	619	636	651	601	605	637	636
Fuel Oil							
Gravity, °A.P.I.	1.2	1.1	1.4	0.9	−0.2	1.0	−0.9
Viscosity, S.F.S. at 122° F.	85	188	291	198	196	182	187
Pour Point, °F.	30	30	50	40	40	40	45

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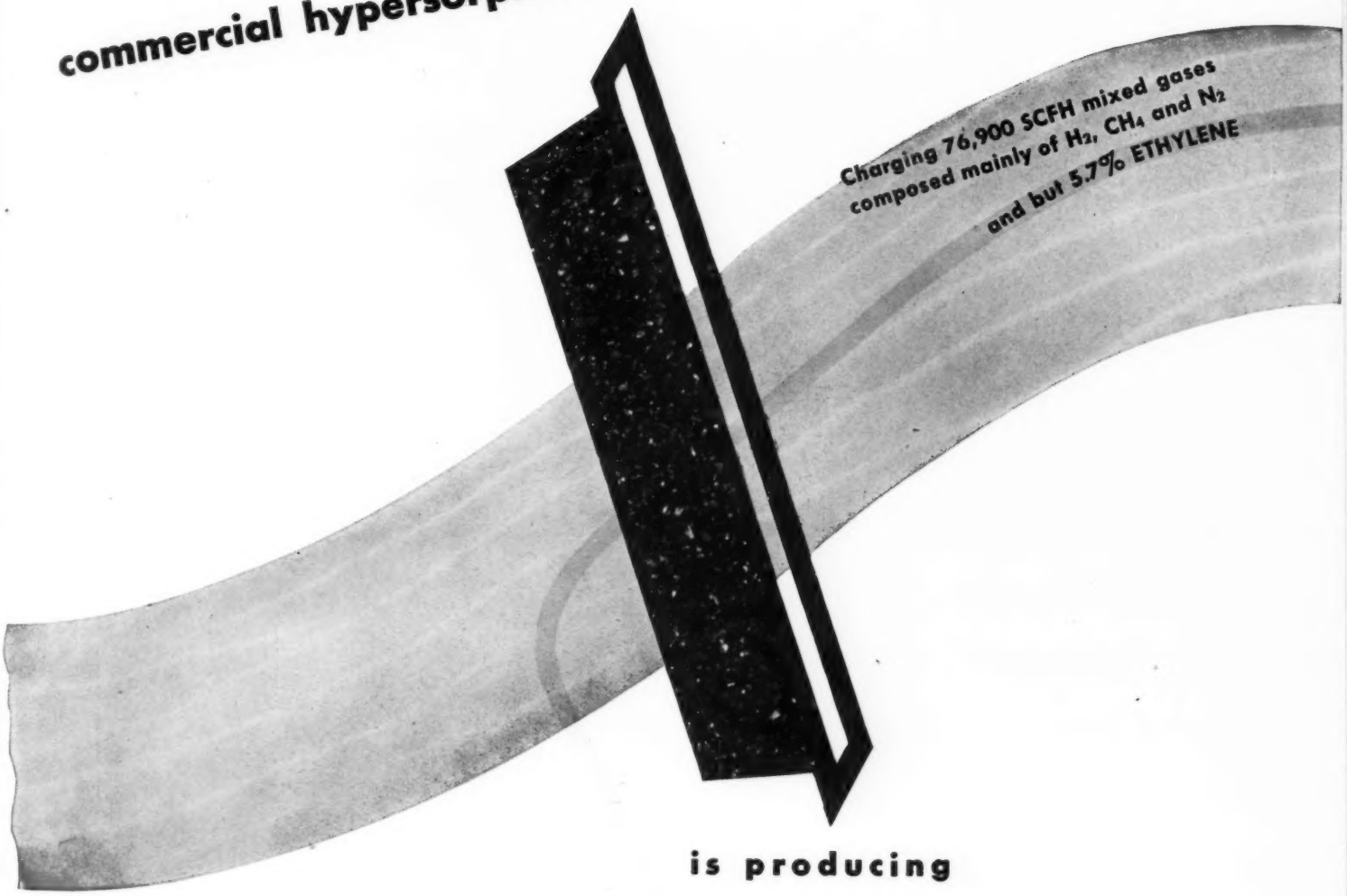

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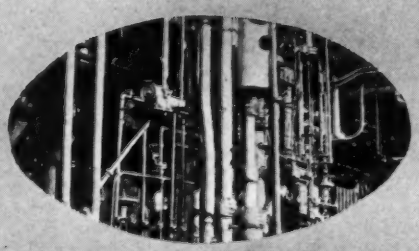

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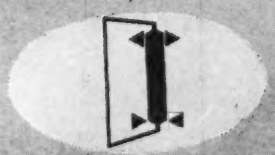


THE IDEA

Ethylene Purification by Absorption *

By *LUDWIG KNIEL*, The Lummus Co., New York, and
W. H. SLAGER, Monsanto Chemical Co., Texas City

The recovery of ethylene of moderate and high purity by the liquid absorption method is described, as used commercially in the Texas City plant of Monsanto Chemical Co. While in this instance the feed charge is effluent from the cracking of propane, the same method is readily adaptable to different charging stocks including refinery off-gases containing propane, ethane and ethylene. The importance of the separation of methane from a gas mixture, fractionation of an ethylene-ethane mixture and the refrigeration requirements are discussed in detail.

Ethylene, important raw material for the manufacture of synthetic organic chemicals, is produced together with propylene and other complex organic compounds as by-products or end-products of cracking reactions from heavier hydrocarbons in petroleum, or as components of coke-oven or manufactured gas during the dry distillation of coal.

As by-products ethylene and propylene are usually rejected in the off-gas from thermal or catalytic cracking units. Where refinery off-gas is not available, or available only in insufficient volume, the pyrolysis of ethane, propane or of selected petroleum fractions furnishes large volumes of gas rich in these constituents.

Table 1 is a typical analysis of three ethylene-bearing streams; (a) a typical coke-oven gas, (b) a refinery off-gas stream and (c) the effluent from a pyrolysis unit charging propane and operated to yield a maximum amount of ethylene. For the three stocks shown, concentration of ethylene varies between 4 and 27 mole % and that of the diluents lighter than ethylene between 94 and 17 mole %. Most commercial gases from which the economical recovery of ethylene or of ethylene plus propylene, might be considered may be bracketed within these limits.

Two fundamentally different processes exist for the recovery of ethylene of moderate and high purity. One involving the use of a solid adsorbent such as charcoal or silica gel has been recently discussed.(1) The other is an application of fractional distillation, two variations of which are at present in operation. The first is a straight low-temperature fractionation process.(2) The second, avoiding very low temperatures in the fractionation system makes use of a liquid absorbent.

It is the second method which is described here, as applied in working up the effluent from cracking propane in the Texas City plant of Monsanto Chemical Co. Fig. 1 is a flow sheet of the Texas City plant.

The water-saturated effluent from the cracking unit is introduced into the effluent compressors where it is compressed in three stages from 1 to 450 psig. The heat of compression is removed by interstage cooling where also more than one-half of the aromatic fractions heavier than pentane, and approximately 95% of the entrained water vapor are condensed. The condensed water is discharged to the sewer. The distillate collected in the second stage separator is pressured to the first stage and that from the first stage is pressured to the compressor suction drum. From there a stabilized aromatic distillate stream is pumped to storage.

Vapors from the last compressor stage, as well as the condensate from the aftercooler, flow to the fractionating absorber. This tower, sometimes referred to as an absorber-stripper, consists of an upper absorption section and a

TABLE 1—Composition of Ethylene-Bearing Gas Streams

	Mole Per Cent (a)	(b)	(c)
Comp.	Coke-Oven Gas	Refinery Off-Gas	Pyrolysis Gas from Propane
H_2	44.0	4.0	10
CH_4	25.0	11.0	25
C_2H_4	4.0	5.0	27
C_2H_6	....	22.0	4
C_3H_6	2.0	11.0	15
C_3H_8	....	45.0	16
Heavier	....	....	3
CO	6.0		....
CO_2	4.0	2.0	....
N_2	15.0		....
Total	100.0	100.0	100.0

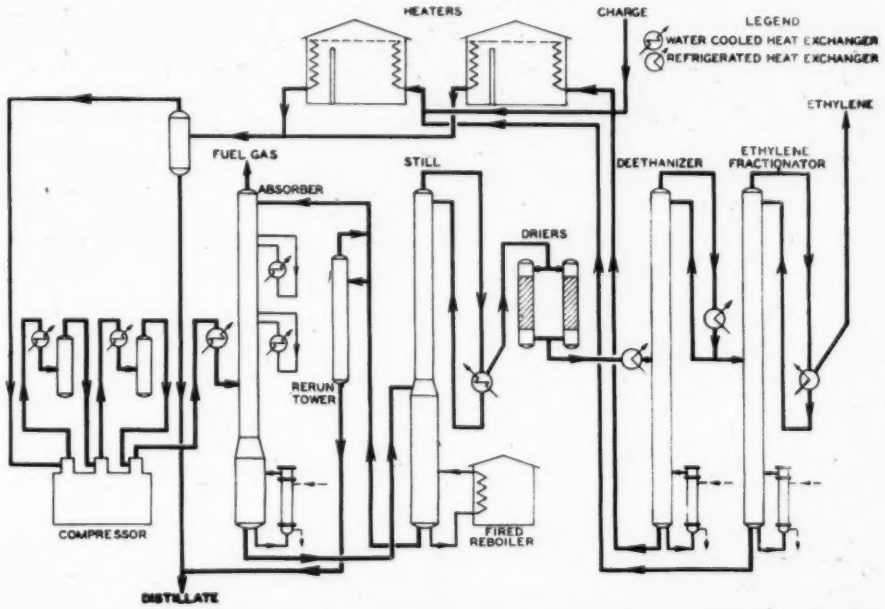


Fig. 1—Flow sheet of Texas City ethylene plant, Monsanto Chemical Co., a general view of which appears on this month's cover

* Condensed version of a paper under the title, "Ethylene Purification by the Absorption Process" by the same authors, presented before the American Institute of Chemical Engineers, Atlantic City, Dec. 3, 1946, and published in full in the July, 1947, issue of *Chemical Engineering Progress*, which replaces the Transactions of the AIChE.

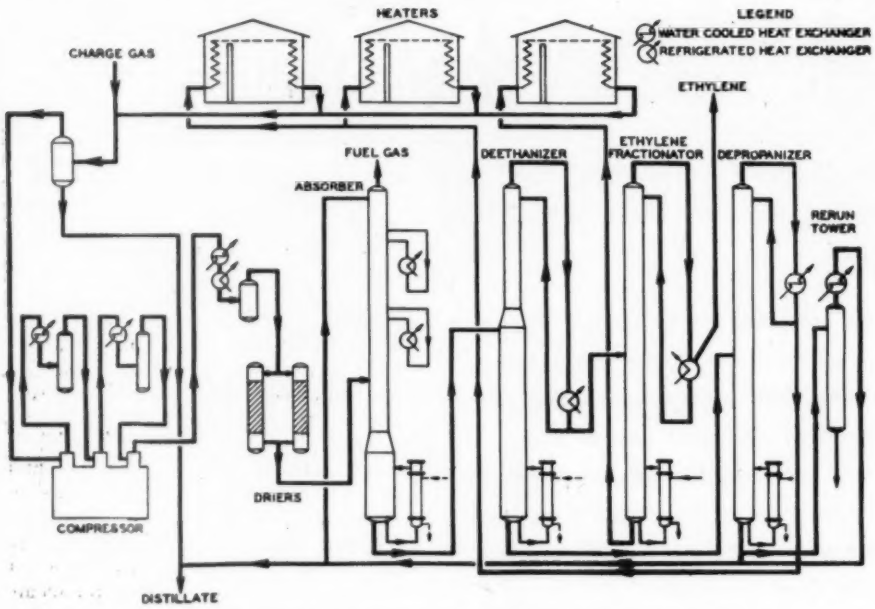


Fig. 2—Flow sheet for a modified plant for ethylene purification

lower stripping, or stabilizing section, and is similar in operation, to any liquid phase fractionator. At the Texas City plant it is operated at 440 psig. and a separation between the methane and lighter and the ethylene and heavier fractions is effected. Aromatic fractions, continuously carried forward by the compressed vapors and retained in the absorption system to the extent desired, furnish the lean absorption oil.

The lean oil enters at 70°F. after it has been cooled by heat exchange with the propane charge and furnace recycle stream. The fat oil leaves at 250°F. and is forwarded to the stripper tower. The stripper overhead consists of the ethylene product and of all furnace recycle material, which includes small amounts of butanes and butadiene, while the absorption oil is returned to the absorber.

The stripper is operated at a pressure of 425 psig. with reflux condensed by atmospheric cooling water. Stripped absorption oil leaves the stripper base at 450°F. so that a direct-fired heater is necessary to furnish reboil heat. To maintain a uniform lean oil quality, a small volume of lean oil is circulated over a rerun tower which is controlled so that absorption oil inventory is maintained. Experience justified design calculations which showed aromatic fractions would be carried forward in sufficient volume to more than offset absorber lean oil loss.

The equilibrium lean oil composition is approximately that shown in Table 3.

The molecular weight of the lean oil averages 82 and the characterization factor as checked from TBP distillation and specific gravity data, is approximately 10.4.

Distillate withdrawn from the compressor suction drum contains more than 50% benzene and toluene by weight, and appreciable quantities of naphthenes, among which cyclopentane and cyclohexane have been identified.

The lean oil clean-up tower bottoms are highly diolefinic in character. An ASTM distillation gives the following results:

IBP, ° F.	211
10%	275
20%	308
50%	381
70%	474
Sp. Gr.	932

Indications are that some of this material is formed from lower boiling diolefins by polymerization in the stripper reboiler, but how much has not yet been determined.

If the plant is operated for optimum ethylene yields, some 12 lb. of oils heavier than propane are produced for each 1000 lb. of propane charged. Slightly more than half of this amount is recovered as distillate from the compressor suction drum. Approximately one-third represents clean-up tower bottoms, and the remainder is made up of heavy oils condensed while quenching the furnace effluent.

THIS MONTH'S COVER

Monsanto's Texas City ethylene plant. In foreground from the left—cracking heater, fuel gas tank, tower structure, lean oil surge tank. Tower structure includes ethylene fractionator, de-ethanizer, still, and absorber. Identical towers of north unit are seen in background.

Operation of Fractionating Absorber

Obviously the purity of the ethylene product is in large measure determined by the performance of the fractionating absorber. The contaminants present in the ethylene product are methane, ethane, and traces of acetylene. Separation of ethylene from ethane does not present any real difficulties, and may be carried to any desired degree. Frequently, to improve tower performance, adjustments are made in the field.

Elimination of the methane in the absorber on the other hand is imperative, since proper functioning of the equipment downstream from the absorber is dependent on absorber performance. Amounts of methane larger than anticipated would jeopardize the operation of the stripper and ethylene fractionator by inability to condense reflux at the specified tower top temperatures.

The absorber is equipped normally with a so-called once-through reboiler and with two or more intercoolers in the absorption section. The feed enters at a point one-third of the number of decks from the bottom deck. The enrichment in the absorption and stripping sections can be calculated once the lean oil rate is known.

To establish a safe lean oil rate, successive approximations of the top and bottom sections are made, until a material balance check over the feed plate is obtained. These approximations may most conveniently be made by using the equations of Edmister[3]. Or assuming a lean oil rate and methane concentration in the stripper bottoms, the stripper section may be computed, plate-for-plate, until a check of the downflow and vapor flow at the feed plate is attained. As there is a steep temperature gradient through the stripping section, calculation of three or four plates is sufficient.

Experience at Texas City has shown that at a pressure of 440 psig. and 70° F. entering oil temperature with dewpoint feed at 100° F. and using an aromatic distillate of the boiling range specified above, a lean oil rate of not more than 4.2 pounds per pound of feed is sufficient to assure the retention of 99% of the ethylene entering in the feed. With this rate the absorber top and bottom temperatures are approximately 180° F. apart and little intercooling is necessary. All of the hydrogen and 96% of the methane is rejected in the absorber overhead.

Fractionation System

The stripper overhead is purified further by fractionation in the de-ethanizer and ethylene fractionator shown in Fig. 1. It first is passed over a pair of activated alumina driers of which one is in operation at a time. The lowest temperature downstream of the driers is 0° F., and experience has shown that if in the

vapors leaving the driers a water vapor dew point below —40° F. is maintained, ice and hydrate formation will not occur over prolonged periods. The limits imposed on drier performance are obviously less exacting than are those of the drier installation of a low-temperature fractionation unit.

Propylene-propane and heavier contaminants are removed from the de-ethanizer base for recycling to the cracking plant. Reflux is condensed by a propane refrigerant evaporating at —20° F. Even though the propylene-propane and ethane may be recycled through separate coils, separation between propylene and ethane need not be sharp. A reflux ratio of 1.5 to 2.0 is adequate under these circumstances. As the yield of ethane from propane is only approximately 5% by weight under average conditions, it is not feasible, in plants of small capacity, to dehydrogenate ethane in a separate coil. In that event, ethylene of the desired purity in respect to ethane is taken overhead in the de-ethanizer and propylene-propane are rejected together as bottoms product for recycling.

At the Texas City plant the ethylene fractionator following the de-ethanizer carries out the separation between ethylene and ethane. When cracking propane, the ethylene concentration in the feed to this tower customarily exceeds 80 mole % which facilitates the separation of the ethylene. With forty decks and an operating reflux ratio of 2.2, practically 100% recovery and a purity of more than 97% (as between ethylene and ethane) are being realized. Stream compositions throughout the distillation system are shown in Table 2.

TABLE 2—Stream Composition/100 Moles of Charge

Component	Charge	Absorber Overhead	Absorber Bottoms	Stripper Overhead	De-ethanizer Bottoms	Ethylene Fractionator Overhead	Ethylene Fractionator Bottoms
H_2	10.9	10.9	...	...	...	...	..
CH_4	26.4	25.2	1.2	1.2	...	1.2	..
C_2H_4	23.7	.3	23.4	23.4	.2	23.2	0.0
C_2H_6	3.7	.0	3.7	3.7	.6	.9	2.2
C_3H_6	15.2	.4	14.8	14.8	14.8	...	0.0
C_3H_8	16.8	.5	16.3	16.3	16.3	...	..
C_4's	1.2	.6	.6	.6	.6	...	..
C_5's plus	2.1	.4	1.7	...	...	...	..
Total	100.0	38.3	61.7	60.0	32.5	25.3	2.2

TABLE 3—Composition of Lean Oil

Component	Boiling Range ° F.	Sp. Gr.	Mole. Wt. M	Weight %
Propylene	—54	..	..	1.1
Propane	—42	..	..	2.2
Butenes	20	..	..	8.2
Butane	32	..	..	.6
Pentenes	32-172	.75	71	5.5
Benzene	172-181	.88	78	44.1
Hexenes	181-228	.85	82	4.4
Toluene	228-234	.85	92	9.9
Naphtha	234-316	.84	110	12.0
Heavier	316 plus	.93	165	12.0
Total			82	100.0

Attainment of ethylene purities in excess of 95% by fractionation becomes increasingly difficult. The measurements of Quinn[4] of the system ethylene-ethane appear to establish the phase equilibrium for ethylene concentrations between 20 and 80% with reasonable assurance. For pressures above 300 psi. abs., the data indicate a growing deviation from the relative volatilities calculated from fugacities. These deviations are in the direction of lowered relative volatilities throughout the concentration

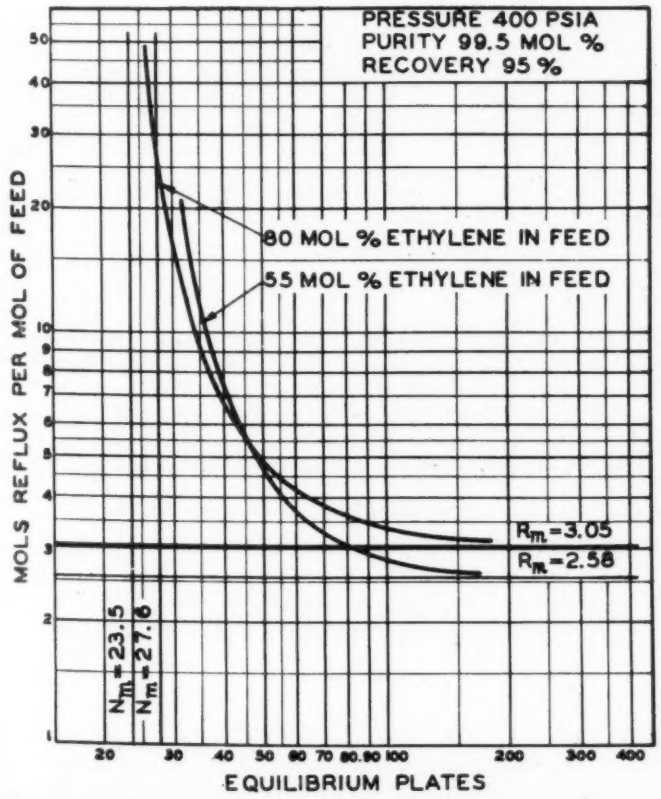


Fig. 3—Reflux ratio vs. equilibrium plates for ethylene-ethane separation in present plant

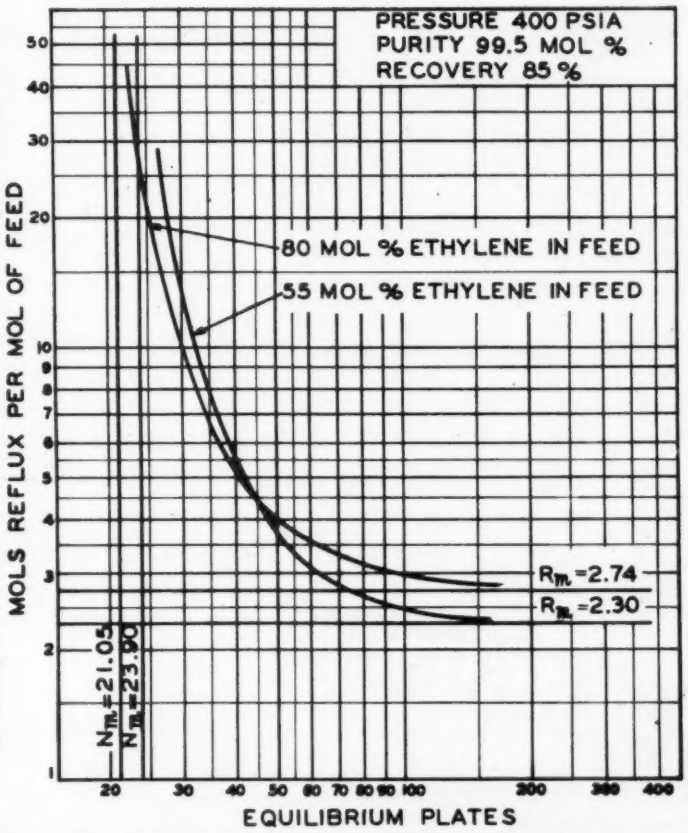
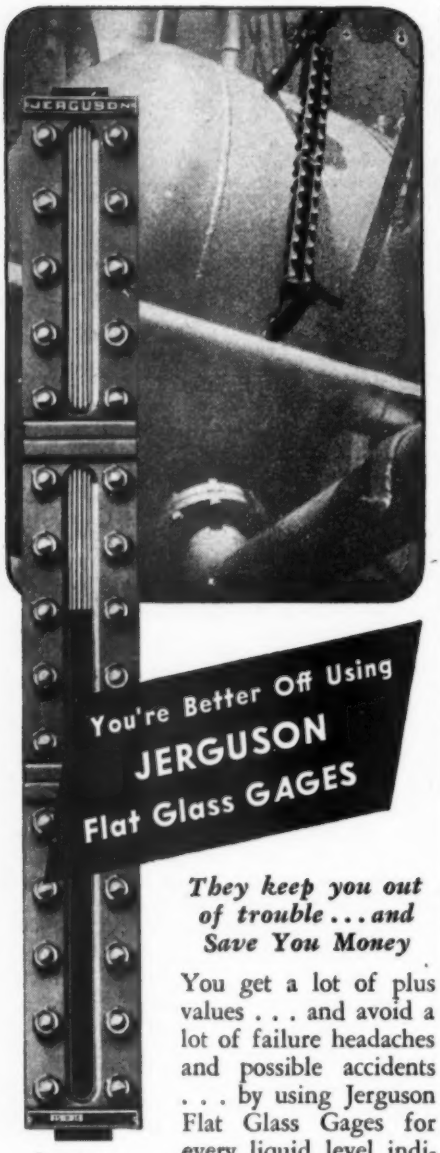


Fig. 4—Ethylene-ethane separation in modified plant



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range but are particularly serious at high ethylene concentrations.

Figs. 3 and 4 show the relationships between reflux ratio and number of theoretical plates for an ethylene purity of 99.5 mole % and 85 and 95% recovery. The reflux ratio is referred to feed as this value affords a more direct comparison of tower reflux requirements. The graphs are based on the data of Quinn. The relative volatilities at high ethylene concentrations obtained by graphical extrapolation of an enlarged X-Y diagram, are:

% Ethylene	80	90	95	100
Relative Volatility	1.306	1.278	1.264	1.25

Further measurements of the system ethylene-ethane in the range of high purities or conclusive test data on commercial units must be awaited before these results can be considered reliable and secure.

Modified Recovery Unit

One of the advantages of the absorptive-type of recovery unit described is that it may be readily adapted to the use of different charging stocks varying widely in composition. Among these are refinery off-gases containing propane, ethane and ethylene, which nearly always represent a composite from various refinery units. As a result of different time cycles of these units and of seasonal changes in refinery commitment schedules, composition and volume of the composite off-gas may fluctuate considerably.

If a composite off-gas is taken directly to the heaters for further cracking, the latter cannot at all times be operated at optimum capacity and for optimum yields. It is in this case desirable to carry out a preliminary resolution of the charge gas into ethylene producing constituents and lighter and heavier material. Also, to even out production during a shutdown, it may, under certain circumstances, be advisable to make up a temporary charge stock deficiency from liquefied storage which can be accumulated during periods of over-supply. Both objectives can most conveniently be carried out by working up charge and furnace effluent gas together in the type of plant described.

The flow sheet of a modified plant is shown in Fig. 2 The charge gas may be combined with the furnace effluent at a suitable pressure stage of the effluent compressors or it may be compressed by separate compressors. The combined high-pressure gas is forwarded through driers to the absorber. To bring all reboilers within range of normal steam pressures, the flow sheet is modified as shown. The fat absorption oil is pumped to the de-ethanizer. The de-ethanizer overhead passes to the ethylene fractionator while the de-ethanizer bottoms are pressured to the depropanizer.

This change requires that the lean oil pass over three towers instead of two as in Fig. 1. However, by cooling and partially condensing the absorber charge and by operating the absorption section of the fractionating absorber at a temperature ranging from 0° F. at the top, to approximately 40° F. at the feed plate, it is possible to reduce, substantially, the volume of lean absorption oil required for comparable performance.

This has the advantage of increasing the proportion of overhead in the feed to the de-ethanizer and depropanizer thus lowering reflux requirements at these towers. The expense for refrigeration to the lean oil cooler and the absorber intercoolers is more than compensated by savings ensuing from a reduction in the lean oil circulation.

As in Fig. 1 lean oil is kept conditioned by a small rerun tower operated so that it will reject either the heavy ends or, in case of an accumulation, also the initial fractions of the lean oil. The refrigerant is a mixture of propylene and propane identical with that charged to the furnace. When recovering a 93% pure ethylene product and at furnace recycle ratios (recycle :fresh feed) of approximately 1.0, the principal tower operating conditions are those shown in Table 4.

Temperatures and pressures shown will vary somewhat with the change of composition of the charge gas and with the furnace recycle ratio.

Refrigeration Requirements

At the Texas City plant a commercial propane charge is used. The same stock is employed in the refrigeration system. Refrigeration is furnished to the de-ethanizer and ethylene fractionator reflux condensers and also in part to the de-ethanizer precondenser. The latent heat of the charging stock is util-

TABLE 4—Summary of Tower Operating Conditions

Designation	p lb./sq. in. gage	Temperature °F. Overhead	Top	Feed	Bottoms	Reflux Ratio mole/mole Overhead
Absorber	460	0	0*	0	125	..
De-ethanizer	450	18	36	120	232	3.0
Ethylene fractionator	385	1	4	20	49	5.2
Depropanizer	220	112	106	225	350	1.0
Rerun tower	25	150	260	350	400 (max.)	0.4

*Temperature of lean oil entering.

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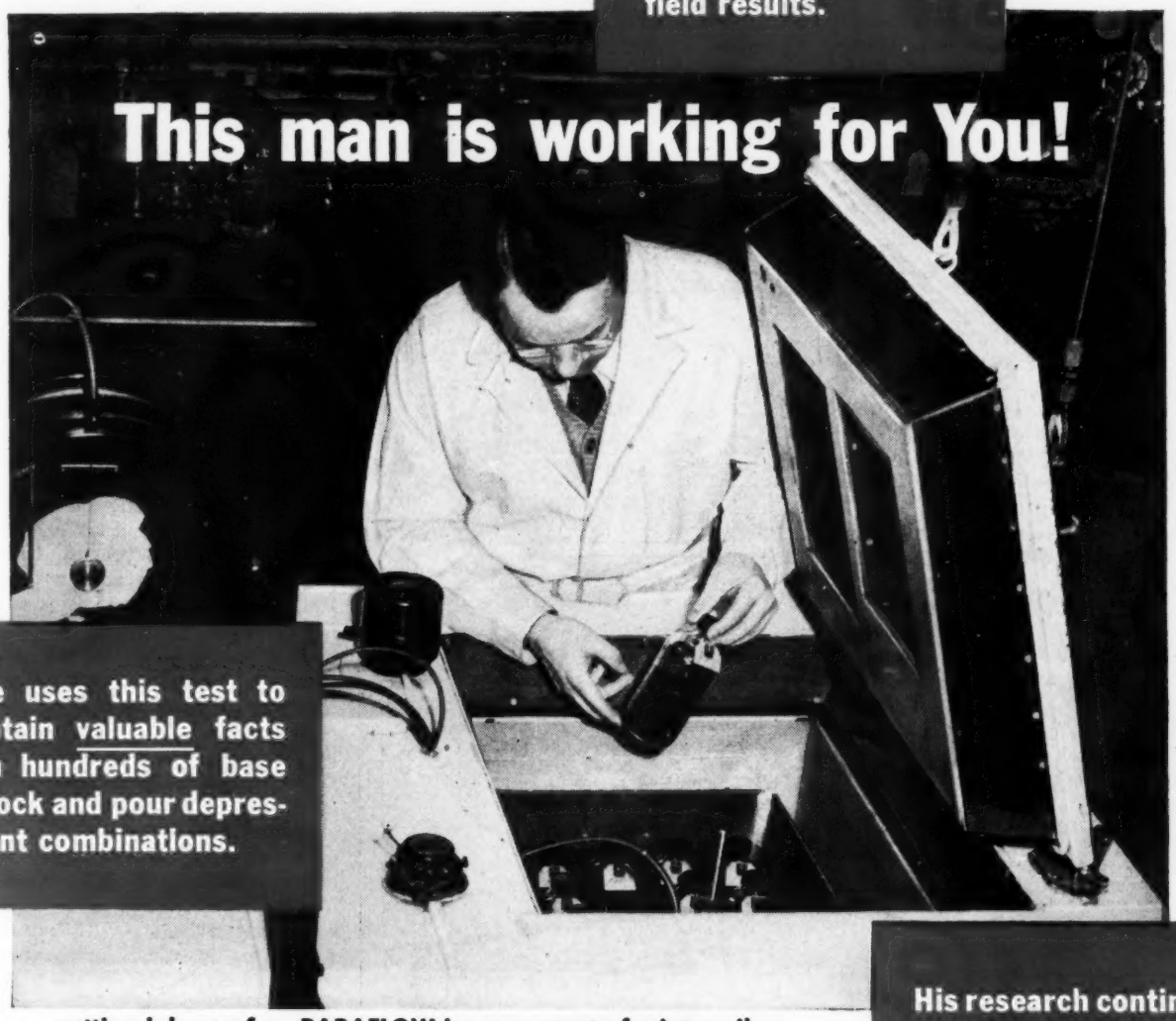

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ized to subcool the lean absorption oil. Salt water is used in the one remaining condenser and in cooling elements. Fresh water recooled by salt water is used for the cooling of all compressor and engine jackets.

The refrigerant is compressed from an average pressure of 3.0 psig. in the low side suction drum to 210 psig. at the discharge end, i. e. by 12.7 ratios in two stages. The refrigerant is not cascaded; an exchanger interposed between evaporators and compressors superheats the refrigerant vapors and subcools the condensed refrigerant. Extensive tests during the summer season when cooling water temperatures range from 92 to 99° F. have shown that the operating load on the refrigeration compressors is very nearly 10 brake hp./1000 lb. net of ethylene a day. Referred to the volume of charge gas to the purification unit, this figure is equivalent to 165 brake hp. a million standard cu. ft. of gas a day. For comparative purposes installed horsepower is of less significance as it reflects the practice of individual operators in regard to spare capacity.

At Texas City one spare compressor is available all the time; the remaining compressors are not fully loaded so that the installed horsepower on the same basis as above is 14.4 B.hp. and 238 B.hp., respectively. Refrigeration compressor downtime is almost entirely due to compressor cylinder valve breakage which can be held to a minimum by superheat on the suction side, the provision of an adequate suction drum, and proper design of the jacket cooling water system.

Refrigeration requirements of a purification unit providing also for prefractionation of the charging stock are higher and, as expected, depend in some measure on the composition of the charging stock as well as the furnace recycle ratios. No one case can be proclaimed typical. It is worthy of note, however, that for an average refinery gas charging stock such as the one listed in Table 1, the refrigeration load of a plant, including prefractionation of the charging stock by the absorption process, is likely to be less than is that of a low-temperature fractionation unit of equal capacity.

The reason for this is that the refrigeration requirements of the demethanizer represent a very large proportion of the total refrigeration needs. The horsepower demand of refrigeration at −150° F. is a multiple of that required at 0° F. If a Carnot cycle is carried out between an evaporator temperature T_1 °R. and a condenser temperature T_2 °R. the work done per B.t.u. removed from the evaporator is $A(T_2 - T_1)/T_1$ where A = 778 ft. lb./B.t.u. and is the mechanical equivalent of heat. If this ratio is computed, for instance, for an evaporator temperature t_1 = 30° F. and a condenser temperature t_2 = 115° F. and also for an evaporator temperature t_1 = −150° F. and the same condenser temperature t_2 = 115° F. it is found that the work in the latter case is 4.9 times that of the former.

Acknowledgment

Acknowledgment is made of the support given in the preparation of this paper by the late Dr. C. S. Comstock of Monsanto's St. Louis office, to H. K. Eckert, plant manager of the Texas City plant, W. W. Kraft of the Lummus Co. and to the office of the Rubber Reserve Corp. for permission to use plant operating data.

References

(1) Berg, Clyde, *Trans. Am. Inst. Chem. Engrs.*, 42, 665-680 (1946), "Hypersorption Process for Separation of Light Gases", *Petroleum Processing*, 2, 300-307, (1947).

(2) Pratt, A. W., and Foskett, N. L., *Trans. Am. Inst. Chem. Engrs.*, 42, 149-163 (1946).

(3) Edmister, W. C., *Trans. Am. Inst. Chem. Engrs.*, 42, 15-32 (1946).

(4) Quinn, J. C., MIT Thesis (1940).

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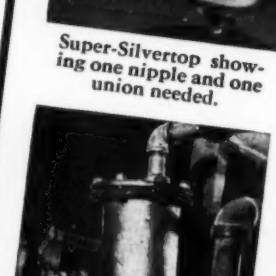

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AIR-COOLED HEAT EXCHANGERS

Their Advantages, Disadvantages and Application

By D. P. THORNTON, JR.
Assistant Editor, PETROLEUM PROCESSING

Advantages of air for cooling process fluids include elimination of most normal water supply problems such as corrosion, tower cleanouts, repairs and chemical treatment. Maintenance is reported to be one-third that of water-type exchangers. Disadvantages are that method is not economic for low temperatures, and that the equipment and operating costs range from 25 to 150% higher.

Variable-pitch propellors permit adjustment of air stream to seasonal requirements. Dual-speed electric drive, or variable-speed drive by steam-turbine or internal-combustion engines, allow savings in power during cool weather.

Natural gasoline plant operators, in many instances, prefer air cooling for primary still overhead product, debutanizer overhead, steam condensing, and engine jacket water. Economics are doubtful for de-ethanizer or depropanizer overhead condenser. An interesting refinery installation was for cooling a fluid from 1500 to 250° F. with 90° F. air, where temperature of discharge air from cooler was 300° F. Costs are given for a number of representative installations.

NUMEROUS natural gasoline plants and an increasing number of refineries, especially in the drier portions of the Southwest, are turning to the use of air for at least some plant cooling.

The idea is not new. Automobiles have cooled engine jacket water by a combination of induced and forced draft for many years. Stationary internal combustion engines use induced draft. Heat in aircraft engines is dissipated generally by air alone and likewise in the familiar household refrigerator. Most air-conditioning installations reverse the idea by heating the refrigerant while cooling the air but the principle is unchanged.

Only within the past 10 years has air cooling been used to any marked extent by the oil industry.(1) A few natural gasoline plants erected steam condensing coils where they would catch the prevailing wind, and early refinery shell stills used air-cooled worms to condense dephlegmator overhead. One of the more recent natural gasoline plant installations is that of Warren Petroleum Corp. at Holliday, Texas, where 80% of the cooling load is borne by air.(2)

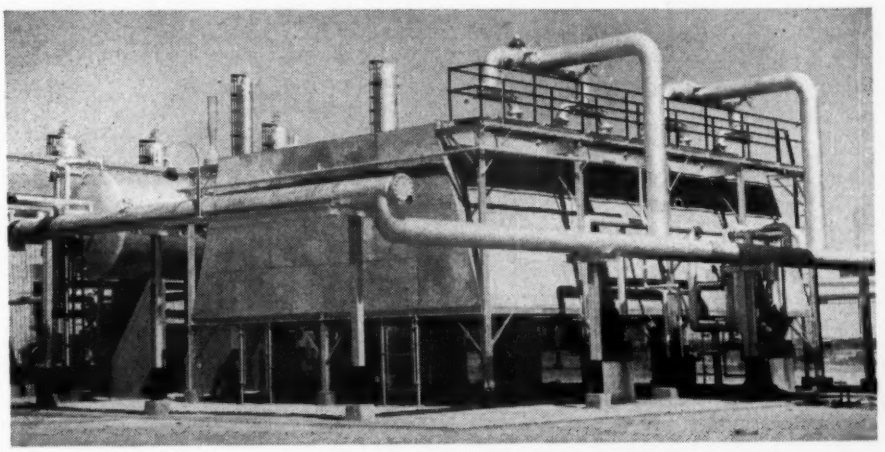
The most obvious advantage of air cooling is that the problems of water supply—quantity as well as quality—can be dismissed. With it go the costs of maintenance expense from corrosion attack (galvanic as well as chemical), coolant make-up, cooling tower cleanout and repair, and chemical treatment of water to avoid scaling, plugging and heat-transfer drop from microbiological fouling.

The upper extremity of temperature gradient involved in the equipment also is less important, for there is no limiting temperature to which air may be heated. There are no water lines to freeze up in winter and no damage to equipment in case someone fails to drain it in freezing weather. Maintenance has been variously reported as up to one-third of that required for water-to-product exchangers.

The debit side of the ledger is equally important, however. By no means is air cooling the panacea for all plant cooling ailments. For instance, "low" temperatures cannot be achieved economically. Usually it is not feasible to attempt an approach closer than 20° F. to the ambient air temperature. Average maximum summer air temperature therefore governs design. For this reason, in many installations it may be desirable to use air for the bulk of the cooling load, depending on water for final product cooling only. This is the practice in the Holliday plant previously cited.(2)

Air-cooled exchangers cost more than the conventional type, which latter cost should properly include that portion of cooling tower facilities required for dissipating the heat. The average cost is 75% more for air cooling but, depending on the duty, actually ranges from 25% to 150% more, largely because of differences in heat conductivities between the involved fluids and air. On an overall payout basis, including water handling, treating and equipment maintenance for the conventional type, the air-cooled systems may prove cheaper, however.

Engineering evaluations for air cooling systems and installations must be handled by experienced personnel. It is important to erect the unit in such manner that recirculation of heated air is at least minimized if not entirely avoided. A number of units originally proved unsatisfactory for this reason, yet there is great flexibility in permissible locations, which include building roofs in con-



Four-fan air-cooling installation, driven by four 35 HP steam turbines, for exhaust steam condensing at Texas gasoline plant

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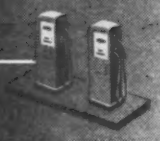

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SOLVAY

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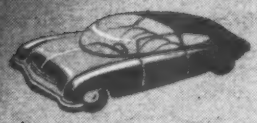
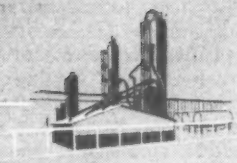
PRODUCTS FOR THE PETROLEUM INDUSTRY



Calcium Chloride
Caustic Potash
Caustic Soda
Chlorine
Soda Ash
Sodium Bicarbonate
Sodium Nitrite



SOLVAY SALES CORPORATION *Alkalies and Chemical Products Manufactured by The Solvay Process Company* **40 Rector Street, New York 6, N. Y.**

gested areas as well as ground locations.

There has been criticisms of air-cooled exchangers where inflammable materials are involved at high temperatures and pressures, on grounds that a leak into a stream of rapidly-moving air could result in a serious conflagration. This is said to be a very infrequent occurrence when equipment is made to careful specifications, subject to rigorous construction and inspection requirements. The air system easily could be designed to carry the flames away from instead of toward other equipment should the hazard be considered sufficient to warrant the additional expense.

Mechanically Simple

The air-cooled heat exchanger is a simple mechanism, as indicated in the accompanying cut-away illustration, Fig. 1. One or more cells containing a number of finned tubes, through which the fluid to be cooled is pumped, constitutes a "section" of the exchanger. Each section is equipped with a fan which either induces or forces a draft of air over the finned tubes. One or more sections constitutes a complete installation.

The particular design of an exchanger illustrated in the photograph is furnished by The Griscom-Russell Co., New York, in conjunction with the Fluor Corp., Ltd., Los Angeles, and is taken as a typical design for discussion purposes. There are several other well-known manufacturers, including the American Locomotive Co., New York, and The Happy Co., Tulsa.

The design illustrated makes use of forced draft, taking cool air from all four sides of the unit below the level of the finned tubes and blowing it through the sections. The fan is of the six-blade variable-pitch type, driven through a reduction gear by electric motor, gasoline or Diesel engine as desired. Turbine drive also may be supplied. The fan is located a certain distance below the level of the tubes, depending on size of the assembly, in order that the entire area of the section will be uniformly supplied with cooling air.

Merits of Forced Draft Design

Particular merits are claimed for this method of design. Forced draft permits economies in size of unit and power requirements. Fans and blowers are rated on the *volume* of air delivered on the high-pressure side of the fan at standard conditions of temperature and pressure. Heat transfer calculations, however, are based on the *weight* of air. Hence a fan rated at 50,000 cu. ft. per minute is delivering 3800 lbs per minute of air at 60° F., while the same fan handling heated air (i.e. induced draft) is supplying only 3270 lbs. per minute at 150° F. Therefore if induced draft were used, other than forced draft of cool air 17% greater *volume* of air must be handled by the fan to circulate the same *weight* of air for a given heat dissipation.

Exhausting heated air upward at high velocity prevents recirculation of hot air through the unit. The heated air, already moving rapidly, tends to go upward due to its lesser density. Hence the fan is aiding a natural process.

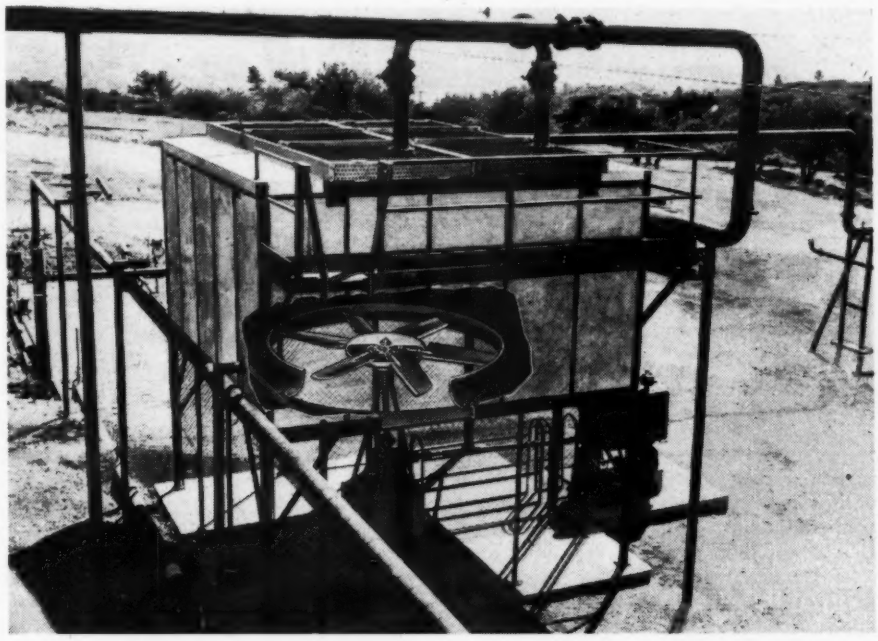


Fig. 1—Cut-away illustration of air cooled heat exchanger

Variable-pitch propellors permit substantial savings in required horsepower. Pitch can be set at the desired angle to deliver only the amount of air required for the cooling job at different times in the year. Driver horsepower requirements therefore vary accordingly. Finally, during very cold weather it frequently is not necessary to run the fans; natural draft then provides all air circulation required.

In some cases the fan-tripod and drive-assembly are mounted on a foundation independent of that supporting the rest of the structure. Both foundations may be connected by a concrete apron under the whole unit if desired, but there is no transmission of mechanical vibration to piping or exchanger sections, thereby tending to minimize leakage possibilities. The superstructure is designed to support only the weight of the exchanger sections and housing, and to resist transverse forces resulting from wind. Hence relatively light structural members are permissible for most of the unit.

Dual-speed electric drives for the fan are most common. This feature permits power savings of up to 70% in the cool seasons in addition to those possible by adjusting fan-blade pitch. Still further power savings can be achieved from steam-turbine or internal combustion engine drives, where a still greater speed flexibility is possible.

The air cooling units are adaptable to almost any condensing and cooling service, can be designed for fluid pressures up to 5000 psi. and temperatures up to 2000° F. (Both maxima in the same unit likely would not be encountered in a practical application, however.) They can be mounted atop existing structures or in limited installation space.

A number of different services can be combined into a single installation; for instance, ammonia, lubricating oil and jacket water cooling. All mechanical equipment is at or near ground level, in easy reach of maintenance crews, and can be serviced in operation except for changing propellor pitch. The cooling sections are at a substantial elevation, providing sufficient static head for suction of condensate pumps and assuring the draining of condensate from the exchanger by gravity.

While only one type of air cooled heat exchanger of forced draft design has been described here, engineers will debate the advantages and disadvantages of such design differences as induced vs. forced draft, vertical vs. horizontal expulsion of heated air, and use of a plenium or distributor-space between fan and cooling sections. This article is not intended to compare the different commercial designs. All use the same basic principle of physics and the choice of the type to be installed frequently depends on individual conditions in the plant.

Water Is Determining Factor

It has been indicated earlier that one of the prime advantages of air-cooling over water-cooling is that the cooling job does not depend on the quality or quantity of cooling water available. However, an air-cooling unit will cost more than a conventional heat exchanger for the same heat dissipation. These two factors, plus the fact that ordinarily a closer approach to coolant temperature can be attained when water is the coolant rather than air (due to the economics involved and the differences in heat conductivity and specific heats), make

TABLE 1—Cost and Size Data for Typical Oil Industry Air-cooled Heat

Total Heat Dissipation Btu/hr.	Cost*	Total Fan hp	No. Fans	Fan Dia. ft.	Fan Drive hp		Ground Space ft.
31,800,000	$50,618.00	96	3	14	40	Electric	66 x 21
10,500,000	29,924.00	44	2	14	30	Electric	32 x 25
6,900,000	17,218.00	20	2	10	10	Electric	16 x 25
		Exhaust Steam Condenser					
19,350,000	13,450.00**	39.5	1	14	40	Turbine	16 x 25
9,062,000	9,678.00	22	2	8	15	Electric	16 x 21
		Still Overhead Condensers					
12,870,000	15,756.00**	31.6	2	10	20	Gas Engine	21 x 21
11,740,000	43,906.00	46	4	10	15	Electric	25 x 46
6,667,000		27.2	2	10	15	Electric	
		Pipeline Compressor Station Gas Cooler					
13,920,000	44,000.00	76	2	14	40	Electric	41 x 11
2,480,000	8,134.00	11	1	8	15	Electric	16 x 11
		Lube Oil Coolers					
1,800,000	13,068.00	42	2	10	25	Electric	25 x 11

* Does not include costs of erection nor tie-in to plant facilities.
** Without Motors.

a thorough evaluation of the two methods vitally important before an installation is authorized.

Ordinarily, where "cheap" water of good quality is involved, there are few applications where air-cooling is economical. Where water is in scanty supply or of poor quality, or both, it probably will be found cheaper to use air-cooling for at least the major portion of the cooling load. In between these two extremes only careful engineering consideration, which most manufacturers are willing to supply, will provide the answer.

Under present unsettled labor and material costs, it is difficult to make any generalization on installation costs, or to compare them with cooling by water. However, installed costs for a number of representative air-cooled installations are presented in Table 1. The figures, supplied by one manufacturer, do not include cost of wiring, piping and fittings, or control instruments.

Regardless of the water supply, air-cooling provides definite advantages in certain cases: For instance, where very high temperatures are involved, the thermal shock which might have to be resisted by the equipment were water the coolant might indicate air-cooling as the best. There is no safe limit beyond which air may not be heated; the optimum heat transfer rate and permissible thermal shock limit may thus be made the maximum for which it is economical to design the tubes containing the fluid to be cooled. These tubes may be copper, brass, plain carbon steel or its alloys, monel and aluminum, depending on the fluid and service conditions involved.

Oil Industry Applications

Some installations, such as in chemical and butadiene plants, need air-cooled exchangers in preference to water-cooling particularly where product contamination in event of a leak cannot be tolerated. Here it is desirable that, should any leaks occur, the product should leak out and contaminate the coolant rather than the reverse.

For natural gasoline plants particularly, several experienced operators state that air cooling will fit into almost every plant for the following services:

1. Engine jacket water cooling.
2. Primary still overhead product condensing.
3. Debutanized overhead condenser.
4. Steam condensing.

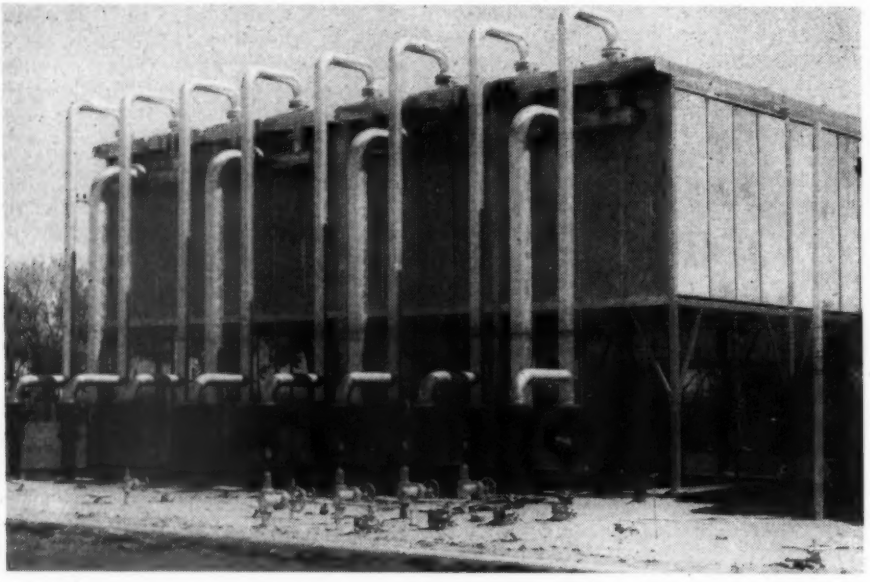
For use as a de-ethanizer and depropanizer overhead condenser, or in conjunction with final cooling by water, the economics usually are doubtful and largely dependent on water supply. In Southwestern summers, ordinarily it is not economically feasible to consider cooling the product below 120° to 130° F. with, say 100° F. air; the unit would have to be excessively large. Depending on the individual plant situation, it may be much cheaper to cool to these minima with air, depending on water for final cooling.

Air cooling is less used in refinery installations than in natural gasoline plants. A few installations have been made for gas oil vapor condensers, catalytic effluent final coolers and condensers following heat exchangers and cooling monoethanolamine vapors in H_2S removal systems.

An interesting refinery installation of several years ago was the cooling of a 1500° F. fluid to 250° F. with 90° F. air; heat exchange with other fluids was not feasible. Alloy piping to this installation, as well as to the initial cooling sections, was perceptibly red-hot even in daytime. Particular care was required in location so that 300° F. air exhausted from the unit would not come in contact with inflammables or accidentally with personnel. This is perhaps an extreme case in refinery application, but it illustrates the potentialities of this method of cooling.

There is no technical reason why air-cooling cannot be used in refineries as a substitute for water-cooling facilities, or in connection with them where "low" temperatures are necessary. Many refineries are perennially troubled, especially in summer, with inadequate water supplies. Great expense is incurred in chemically treating and maintaining these water systems. Here, authorities state, combination air and water cooling should demonstrate attractive pay-out possibilities.

Such applications as residuum cooling after heat exchange, overhead vapor cooling and condensing, steam condensing, engine jacket water cooling and the like seem likely candidates in minimizing summer water-famines.



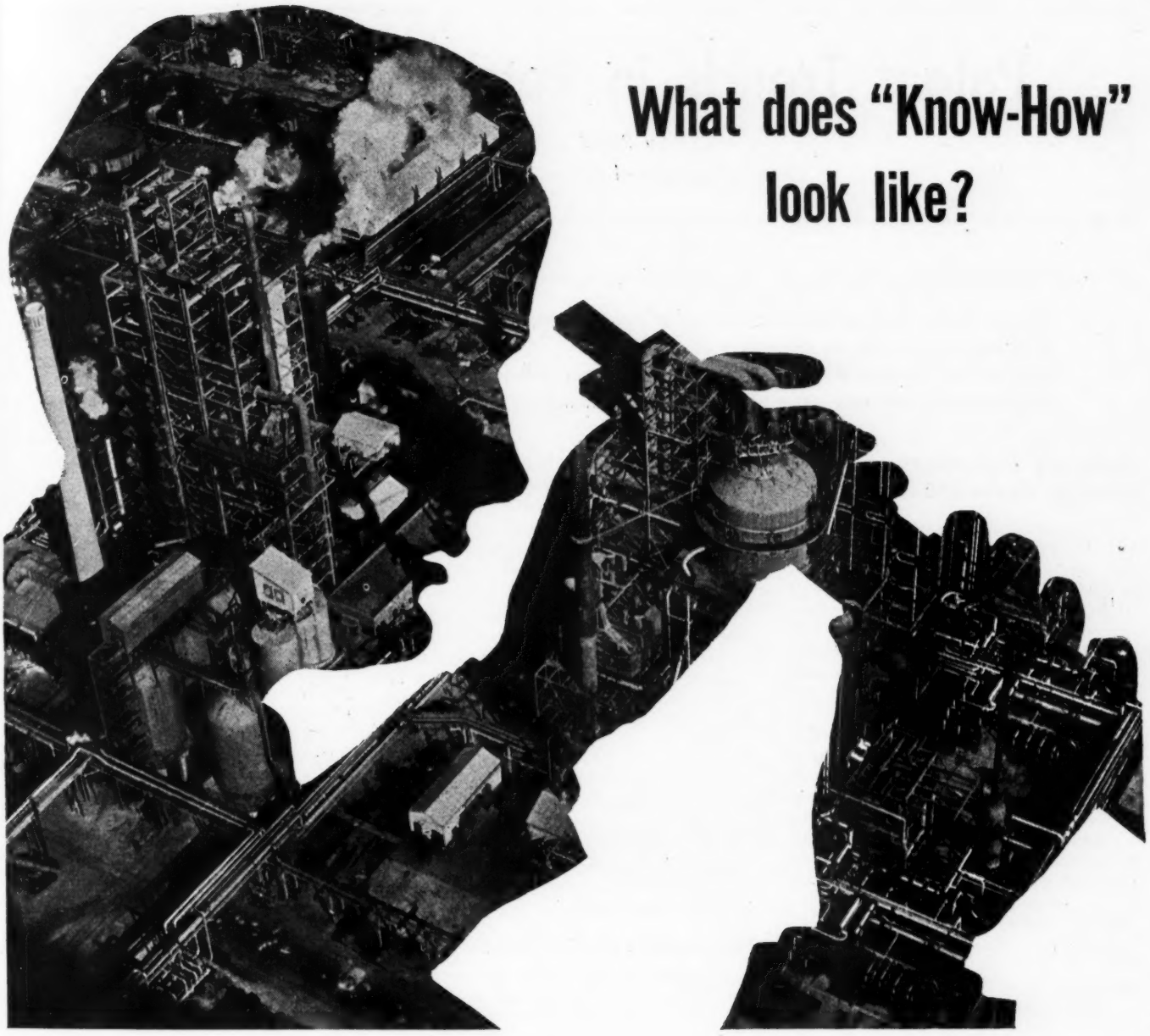
Air-cooling installations at Kansas gasoline plant. Left is four-fan unit, driven by four 50 HP motors, for engine jacket water cooling; right is two fan unit, driven by two 30 HP motors for natural gas cooling

References

(1) Demarest, K. D., "Air Cooling, Its Status and Possibilities," Reprint from Calif. Oil World, Dec. 1945.

(2) Thornton, D. P. Jr., "Water Scarce—Natural Gasoline Plant Uses Air for 80% of Required Cooling," PETROLEUM PROCESSING, 2 No. 1, p. 52 (1947).

What does "Know-How" look like?



"Know-how" can't be seen in the ordinary sense — yet it becomes instantly evident when the earning power of refining units is studied — for the profit potential of a refining unit extends only as far as the experience, skill, training, imagination and courage of the men who design and build it.

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Patent Trends in Petroleum Refining

By PETER J. GAYLOR

Patent Attorney and Editor "The Technical Survey"

Developments disclosed in the patents reviewed below include:

Convert higher hydrocarbons to isobutane with HF catalysis
Silica adsorption aids in extraction of aromatics
New process to absorb oxygen from air by copper chloride
Chemical firms realizing value of petroleum for chemicals

Isobutane from Higher Paraffin Hydrocarbons

In the presence of substantial proportions of hydrofluoric acid and under suitable conditions of time and temperature, saturated hydrocarbons are reconstructed to hydrocarbons of different carbon-skeleton arrangement and different boiling point. For example, paraffin hydrocarbons undergo conversion to isomers and to hydrocarbons of both higher and lower molecular weights.

In its U. S. patent 2,418,023, Phillips Petroleum Corp. discloses that in presence of catalysts, such as hydrofluoric acid, with minor proportions of boron fluoride added, elementary hydrogen has a directing influence on the reconstructing hydrocarbons, and catalyst life is also increased. Of course, it tends to hydrogenate unstable compounds and also tends to suppress polymerization.

In the case of higher normal paraffins such as heptane, an overall reaction somewhat according to the following equation appears to take place:

$9C_7H_{16} + 5H_2 \rightarrow 9$ iso $C_4H_{10} + 3$ iso $C_5H_{12} + 2$ iso C_6H_{14}

The reaction involves cracking, isomerization and hydrogenation, while in the case of the lower molecular weight normal olefins, only the latter two reactions occur to any great extent:

$$C_4H_8 + H_2 \rightarrow \text{iso } C_4H_{10}$$

In the latter case, the liquid hydrofluoric acid to olefin ratio is rather high, 3-4 to 1, and hydrogen pressure employed is about 1000 psi, with 0.1 - 10% of the catalyst as boron trifluoride.

Data on conversion of higher normal paraffins in this manner are given in Table I. It will be observed that almost 89% conversion of n-pentane or n-hexane are possible, with the product containing 25-32% by weight of isobutane and 18-20% isopentane, with up to 13% of neohexane and other highly branched paraffins. The only objections to the process are the high ratios of catalyst to hydrocarbon treated and possible difficulties in separating the catalyst from the gaseous reactor products.

Separation of Hydrocarbons

In view of the fact that several oil companies are now working on the extraction of aromatic hydrocarbons from petroleum fractions by the use of silica adsorption (1), it may be well worth while to discuss a recent patent (U. S. 2,398,101) issued to Sun Oil Co. on this subject.

A cyclic system has been evolved in which the polar compounds (aromatic hydrocarbons) are first adsorbed by percolation with active silica gel, after which the gel is percolated with a desorbing liquid (such as pentane) to remove the aromatic hydrocarbons. The adsorbent is steamed (after about 18 cycles) and air at 150°C is blown through it until its (substantially) original activity is restored, whereupon cyclic operation is resumed.

In one example, a contact tower containing one ton of 28-200 mesh silica gel was used in a cyclic operation wherein an East Texas straight run gasoline fraction of 131-320°F. A.S.T.M. boiling range, containing 7.5% aromatics, was percolated, there being 480 gals. of the gasoline fraction used. About 960 gals. of pentane are employed for desorption.

The pentane solution of desorbed hydrocarbons is distilled to recover pentane, leaving an aromatic-rich residue of about 23 gals., the composition of which is as follows:

Benzene	5%
Toluene	20
Xylenes	40
Heavier aromatics (mostly C_9)	23
Saturated hydrocarbons	12

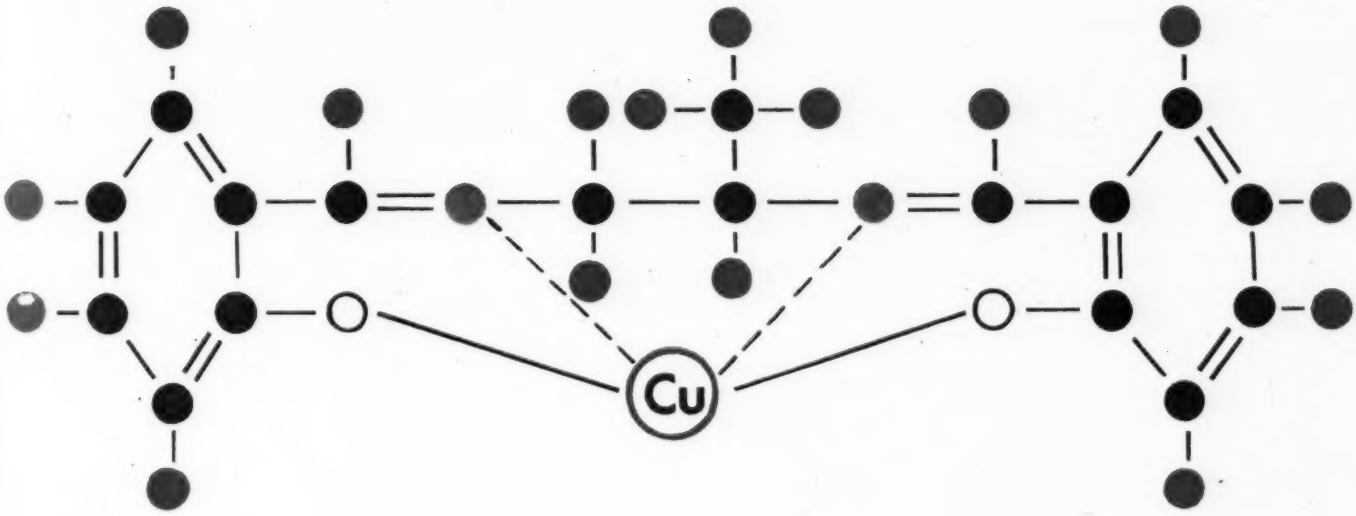
This fraction represents about 65% of the total aromatic content of the original gasoline and has an aromatic content of 88%. Its IMEP blending value is about 325, making it particularly valuable for high grade aviation gasoline.

It is also possible to employ a desorb-

TABLE 1—Data on Conversion of Higher Normal Paraffins

Run No.	5		6		7		8		9		10		11		12		13	
	Gm.	Wt. %	Gm.	Wt. %	Gm.	Wt. %	Gm.	Wt. %	Gm.	Wt. %	Gm.	Wt. %	Gm.	Wt. %	Gm.	Wt. %	Gm.	Wt. %
HF	131	97.4	116	96.9	116	96.8	116	96.8	127	94.1	107	95.5	116	98.0	116	97.0	116	96.0
BF_3	3.5	2.6	3.7	3.1	3.8	3.2	3.8	3.2	8.0	5.9	5.1	4.5	2.4	2.0	3.6	3.0	4.8	4.0
Paraffin:																		
Identity			Normal Hexane						2-Methyl Pentane				Normal Pentane					
Grams	82		82		82		82		65		65		76		76		77	
Hydrogen, p.s.i.	0		100		25		27		0		240		0		53		1,085	
Contact Time, Min.	30		90		33		10		18		20		20		30		30	
Temperature, °F.	178		178		176		176		129		140		165		167		176	
Conversion of Paraffin, %	88.8		Low		83.9		57.7		....		....		88.2		24.4		Very low	
Composition of Effluent Hydrocarbon, Per Cent by Weight:																		
Propane	2.54		96%		1.55		0.38		1.48		....		0.86		.....		98%	
Isobutane	25.16		Boiling		11.11		2.19		29.65		3.72		31.60		0.94		Boiling	
N-butane	5.23		from		0.92		0.25		4.94				5.64				from	
Isopentane	18.37		149		15.39		0.65		19.40		2.30		20.43		22.07		91	
N-pentane	3.69		to		1.72		0.94		2.37		....		11.80		75.56		to	
Neohexane	13.26		158° F.		15.74		6.23		8.74		3.09		4.56				104° F.	
Diisopropyl	1.40		indicating		1.35		9.21		1.71		16.16		1.30				indicating	
Methylpentanes	8.63		very low		19.65		33.46		10.13		71.87		11.00		1.43		very low	
N-hexane	11.20		conversion		16.14		42.29		2.74		....		....				conversion	
Isopentane	6.30				9.80		1.44		6.92		2.12		6.08					
N-heptane and heavier	4.22				6.63		2.96		11.92		0.74		6.73					
	100.00				100.00		100.00		100.00		100.00		100.00		100.00			

DU PONT METAL DEACTIVATOR TO KEEP COPPER OUT OF MISCHIEF



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ing agent which boils above the boiling range of aromatic-containing fraction, and one such liquid specified is a 300-500°F heavy alkylate which also contains about 1% aromatics.

Oxygen Production

Oxygen is assuming ever increasing importance in petroleum and other industries. In fact, the new era of cheap oxygen was introduced by the new synthetic gasoline plants at Carthage and elsewhere. It can be noted that oil companies are directing attention towards the production of this gas. In fact, Socony-Vacuum Oil Co. was issued, not long ago, U. S. Patent 2,418,402 on the manufacture of oxygen from air by the use of absorption in copper chloride.

The process essentially comprises a two stage operation in which oxygen is absorbed from air by a copper chloride melt in one stage, and the oxygen is desorbed from the oxidized melt in the second stage, the melt being circulated continuously through the process stages. Since the melting points of copper chlorides are high (cuprous 422°C and cupric 600°C), they are admixed with other chlorides as melting point depressants, e.g. lead, zinc, stannous or alkali metal chlorides. A preferred melt is a mixture of cuprous and cupric chlorides containing 25-45 mole per cent potassium chloride. The freezing point of a melt containing 30% (mole) potassium chloride, 15% cupric chloride and 55% cuprous chloride is around 255°C (490° F), which is about 70°C (158°F) below the minimum operating temperature of any step in the process, the melt possessing relatively high oxygen absorptive properties.

The reactions involved in the oxygen absorption step may be represented as follows:

(1) $2\ Cu_2Cl_2 + O_2 \rightarrow 2\ CuO \cdot CuCl_2$

(2) $2\ CuCl_2 + O_2 \rightarrow 2\ CuO + 2\ CuCl_2$

Reaction 1 represents the nature of the reaction when the process is operated so that the cupric oxide formed remains in solution, while Reaction 2 represents the nature of the process when solid cupric oxide is precipitated during the oxidation. Since the solubility of the cupric oxide in the molten mixture is relatively low, the conversion per pass must be low if it is desired to operate with a homogeneous liquid. For this reason this manner of operation is not very desirable.

The preferred method of operating the process is to absorb oxygen by the oxychloride saturated melt, and this process results in production of a pure desorbed oxygen containing very little chlorine. Undissolved cupric oxide is held in suspension in a highly dispersed state, and conversion per pass is limited only by the amount of cupric oxide which can be held in the suspended state, and if the melt is supported by an inert powdered solid, the limitation practically disappears.

In the desorption step, pressure and

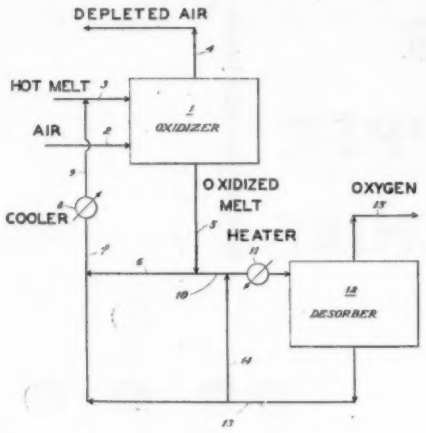


Fig. 1—Diagrammatic sketch of steps involved in Socony-Vacuum's process (U.S. 2,418,402) for manufacturing oxygen from air by use of absorption in copper chloride

temperature conditions are changed so that the supended cupric oxide reacts with the intimately associated oxychloride solution of cupric chloride, to form free oxygen, and cuprous chloride according to Reaction 3, although cupric oxide normally is stable up to 1100°C:

(3) $CuO + CuCl_2 \rightarrow Cu_2Cl_2 + \frac{1}{2}\ O_2$

The process may be more readily understood by referring to Fig. 1 which represents a diagrammatic sketch of the steps involved. Air is introduced into oxidizer 1 through line 2. In oxidizer 1 it is contacted with hot melt coming in from line 3, and the temperature in the oxidizer is maintained at about 350°C-400°C. Oxygen is thus absorbed from the air by the melt and the depleted air is discharged through line 4. To control temperature in oxidizer 1, part of the melt may be withdrawn through lines 5 and 6 and cooled by cooler 8 before it is recycled back to the oxidizer.

The oxidized mixture is passed through heater 11 where the temperature is raised to 425°-550°C and desorbed oxygen liberated is drawn off through line 15 while the desorbed melt is recycled through line 13, back to oxidizer 1. To maintain higher temperature in desorber 12, part of the melt may be recycled through line 14 through heater 11.

Conversion per pass in the oxidizer may be as much as 40% of the total copper of the melt.

Chemicals from Petroleum

Chemical patents are assuming a major proportion of the patents issued to the more active petroleum firms, and many of the oldtime chemical firms are beginning to realize the value of petroleum as a chemical raw material.

In its U. S. 2,419,131 Du Pont discloses a process for carboxylation of isoolefins, particularly with the purpose of producing trimethylacetic acid. In one example, a silver-lined pressure reactor is charged with 134 parts of 73% aqueous sulfuric acid. The air above the acid is then evacuated and 56 parts of isobutylene admitted. Thereafter, carbon monoxide is admitted to a total pressure of 200 atm. and the reactor is gradually raised to 100°C while it is shaken, and the temperature maintained for a period of 8 hrs. During this time, there is a pressure drop of 90 atm.

The liquid product is diluted with water and the upper layer (which is almost completely soluble in caustic) is washed with water. Total yield of organic acids is 54 parts, of which trimethylacetic acid constitutes 60% by weight.

Other olefins reacted in this manner were triisobutylene and vinyl cyclohexene, which is a dimer of butadiene.

U. S. Patent 2,398,612 issued to Shell Development Corp. describes the use of a peroxide-inactivating silicon carbide porous aggregate catalyst in the oxidation of hydrocarbons. This product is made by the Carborundum Co. of Niagara Falls, N. Y. and is essentially silicon carbide bound together with 5-25% of a material whose composition is:

Alkali ($K_2O + Na_2O$)	8.5 %
$Fe_2O_3 - TiO_2$, $MgO - CaO$	0.75
$Al_2O_3 - SiO_2$	90.75

When propane and oxygen, in the ratio of 14:1 are passed through a Pyrex reactor containing this material, more oxygen was found to be reacted (compared with an open tube) and a higher yield of carbonylic compounds was obtained.

References

(1) *Technical Survey* 1947, p. 474.

Selected Patents of the Month

U. S. 2,425,745 and 52 (Philips Petroleum)—Recovery and separation of HF.

U. S. 2,425,754 (Standard Catalytic Co.)—Hydrogen by fluidized technique.

U. S. 2,425,824 (Standard Oil Development)—Phenolic sulfides.

U. S. 2,425,858 (Standard Oil Development)—Isomerization.

U. S. 2,426,087 (Shell Development)— Conversion of hydrosulfides to neutral sulfur substances.

U. S. 2,426,088 (Standard Oil Development)—Eliminating foaming in olefin recovery.

U. S. 2,424,588 (Standard Oil Development—Lubricant containing polyester thickener.

U. S. 2,424,636 (Tide Water Associated Oil Co.)—Catalytic dehydrogenation of hydrocarbons.

U. S. 2,424,637 (Tide Water Associated Oil Co.)—Aromatization.

U. S. 2,424,691 (Socony-Vacuum Oil Co.)—Interpolymerizing thiophene with vinyl esters.

U. S. 2,424,953 (Socony-Vacuum Oil Co.)—Synthetic lubricant.

U. S. 2,424,987 (Danciger Oil & Refineries)—Concentration of acetylene.

U. S. 2,424,997 (Houdry Proc.)—Aviation gasoline.

U. S. 2,425,087 (Universal Oil Products)—Titania-boria conversion catalyst.

U. S. 2,425,096 (Universal Oil Products)—Cyclizing a ketone to trialkyl benzene.

U. S. 2,425,098 (Universal Oil Products)—Catalytic conversion.

U. S. 2,425,174 (Socony-Vacuum Oil Co. Inc.)—Lubricant for cold rolling steel.

U. S. 2,425,267 (Phillips Petr.)—Acrylonitrile from acetylene and HCN.

U. S. 2,425,268 (Texas Co.)—Isomerization.

Moving Bed 'Cracker' Is Economic For Throughputs up to 4000 b/d

In addition to the economical, small catalytic cracking unit described below, this month's review of new and improved devices used in petroleum processing and handling operations on which patents have recently been issued includes:

- ***New fitting design simplifies replacing damaged pipe section***
- ***Novel repair tool removes dents from thin-walled metal tubing***
- ***Tank roof permits fast drainage and cuts corrosion on underside***

SPECIFICALLY DESIGNED for use by the smaller petroleum refinery, a newly patented, moving-bed type catalytic cracking unit is said to be most economic where the charge rate is between 1000 and 4000 b/d.

It provides for direct heat exchange between conversion and regeneration zones, eliminating the need for costly heat transfer tubes and auxiliary external heat transfer fluid circulation systems.

The unit is said to require less space than conventional systems and can therefore be tied in with existing thermal cracking feed preparation and product fractionation equipment. Fig. 1 is a diagrammatic view of the unit in vertical cross section.

Operation is as follows: Catalyst is charged to the unit through line 22, to approximately the levels shown in Fig. 1. It passes downward from chamber 34 through pipes 16, which constitute the regeneration zone. Distribution partitions 62, 63, and 64 assure uniform flow to the pickup ports 66 in the center conveyor.

Catalyst moves up through conveyor conduit 13 in a substantially compact column and is discharged into conversion zone 35 through ports 70 or 71, which can be controlled for obtaining the desired level in the conversion zone. By this means the hydrocarbon space velocity may be varied without change in the throughput, thus avoiding upset of the operation of the product recovery system.

Catalyst then moves down through conversion zone 35 and through vapor distribution pipes 44 into purging zone 104, and thence through pipes 73 into seal gas zone 102. There it is picked up by conveyors 14 and 15 and returned to its starting point in chamber 34.

Regeneration air enters the vessel at line 36, and then passes upward through pipes 16 countercurrently to catalyst flow. Pipes 16 act as heat transfer media between regeneration zone 16 and conversion zone 35. Flue gas is withdrawn from the top of the vessel through conduit 19.

Hydrocarbon vapors heated to the desired feed temperatures enter at line 38, pass through distribution devices 44 into conversion chamber 35 and out through conduit 18.

Inert seal gas, and purging gas such as steam or flue gas, is admitted to chamber 102 through line 37. Part of it enters conversion zone 35 through devices 73 and 44. Another portion enters conveyors 14 and 15, finally mingling with the effluent gases from regeneration. The final portion enters conveyor casing 13 through inlet vents 72.

Diaphragm Valve Control

The rate of admittance of seal gas is controlled by diaphragm valve 40, actuated by differential pressure control 39 so that its pressure is maintained a fixed amount above the gaseous pressure of charge vapors. In addition, the gaseous pressure in chamber 34 is maintained a fixed amount below the seal gas pressure by means of throttling valve 20 on the flue gas outlet. This arrangement also automatically provides a seal gas pressure within the conveyor casing 13 above that at either end.

It is pointed out that an exact heat balance between regeneration and conversion reactions may not be obtained for every set of conditions. In order to prevent a gradual rise in the overall temperature of the entire cycle, cooling tubes 49 are provided in the bottom section 12 of the unit.

The rate of heat removal by these tubes is easily controlled by control of the level of volatile liquid heat transfer fluid in the tubes, through valves 58 and 61 and controller 59. Conversely, tubes 49 may also be used if desired to add heat to the process.

Or, the tubes 49 can be eliminated entirely if the rate of flow of catalyst is carefully controlled so as to maintain a heat balance between conversion and regeneration reactions. Catalyst flow rate is controlled by variable speed motors 24, 25, and 26. It is emphasized this method is not to be confused with that in which catalyst flow is controlled so as to limit the rate of coke deposit.

The plan view in Fig. 2 indicates the

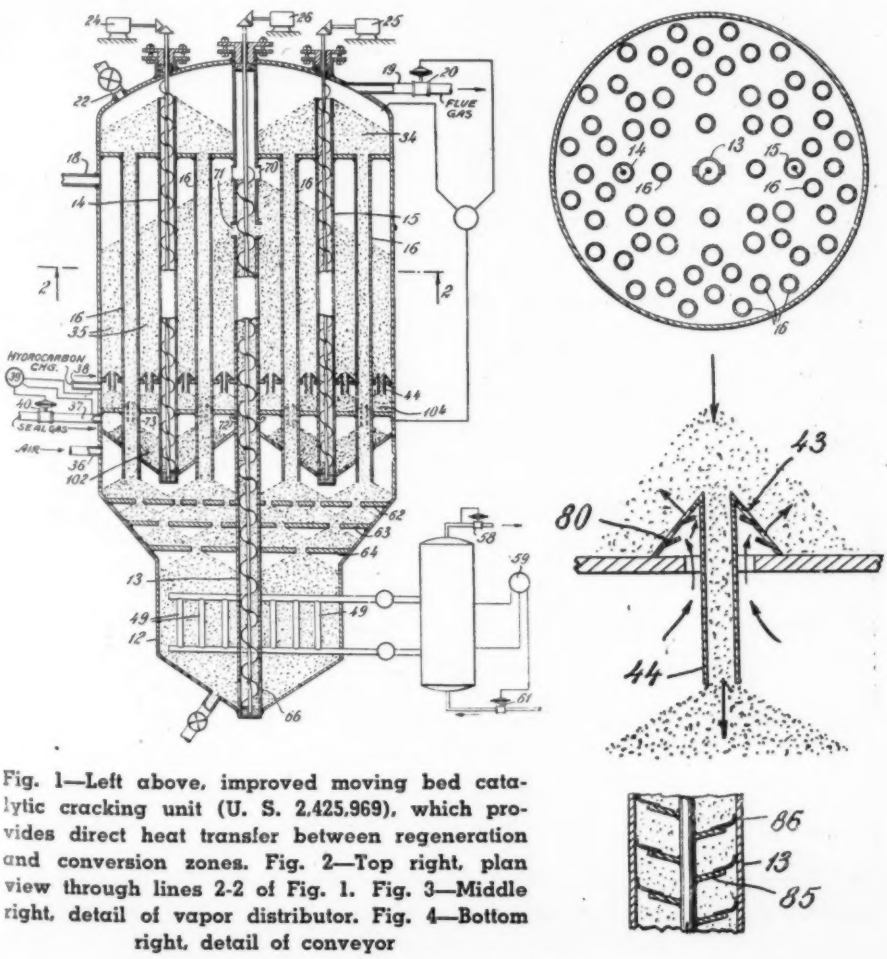


Fig. 1—Left above, improved moving bed catalytic cracking unit (U. S. 2,425,969), which provides direct heat transfer between regeneration and conversion zones. Fig. 2—Top right, plan view through lines 2-2 of Fig. 1. Fig. 3—Middle right, detail of vapor distributor. Fig. 4—Bottom right, detail of conveyor

large number of regenerator tubes 16, and the locations of conveyor tubes 13, 14, and 15. Further conveyors may be added, if desired. The use of vessels of other than circular cross section is also provided for in the invention.

The design of vapor distribution devices 44 or 74 is shown in Fig. 3. Catalyst flow is downward through central pipe; vapor flow is upward through annular space surrounding the pipe and thence through slots 80 in cone 43.

Conveyors as used in casings 13, 14, and 15 are detailed in Fig. 4. They differ from the conventional type in that spiral flange 85 extends substantially short of the casing wall. Attached to the flange 85 is a spring metal tip 86 which presses against the wall. This tip is made of very thin metal so as to prevent undue friction and wear. At the same time, by pressing tightly against the wall, it eliminates the crushing of solid material.

An advantage in the design of this small type cracking or conversion unit is that it may be constructed and substantially assembled in fabrication shops before shipment to small refineries. It can then be quickly installed with a minimum of cost and trouble.

U. S. 2,425,969, issued August 19, 1947, to Ernest Utterback, assignor to Socony-Vacuum Oil Co., Inc.

New Fitting Design Simplifies Replacing Damaged Pipe Section

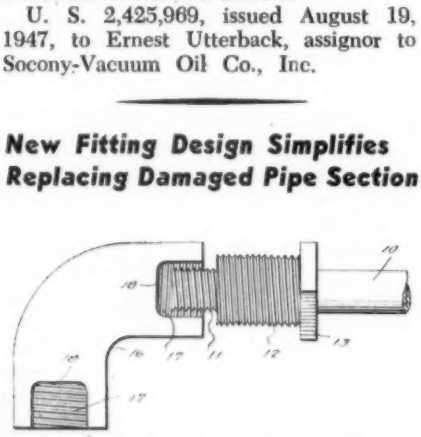


Fig. 5—Slot 18 in fitting 16 permits easy replacement of pipe sections (U. S. 2,425,817)

THE TEDIOUS JOB of removing a great many pieces of pipe in order to replace one damaged section is eliminated by a newly designed fitting, which is slotted on one side.

Shown in Fig. 5 in the form of an ell (although the design may be adapted to any type fitting), the slot, or cut-out 18, is made large enough to accommodate the pipe section 10.

Pipe section 10 is provided with an extra long threaded section 11, on which is fitted reducing sleeve 12. A nut-like flange 13 on the sleeve facilitates the operation of the sleeve. The inner thread of sleeve 12 extends throughout its bore. The fitting 16 has the usual convention inner threads 17.

When a section of pipe is to be removed, the sleeve is simply unscrewed and the pipe pulled out through the cut-out. With conventional fittings, it would be necessary to break the line at the nearest union.

U. S. 2,425,817, issued August 19, 1947, to Edward A. Mosca, Atlantic City, N. J.

Novel Repair Tool Removes Dents From Thin-walled Metal Tubing

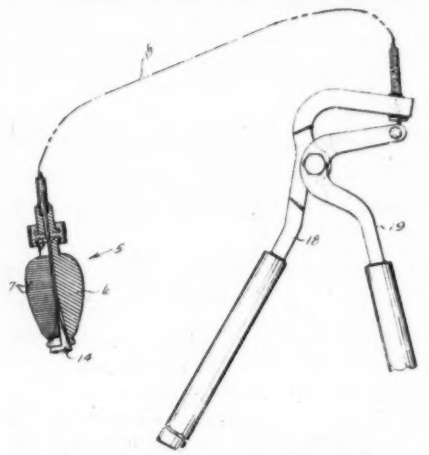


Fig. 6—Repair tool returns flattened metal tubing to serviceable condition (U. S. 2,423,458)

ALTHOUGH PRIMARILY for removing dents, flat spots, and the like from aircraft oil lines constructed of aluminum or copper tubing, a new repair tool may also be used in returning to serviceable condition any such types of thin-walled conduit.

The device, capable of negotiating several sharp bends in the tubing, is shown in Fig. 6. In operation, handles 18 and 19 squeezed together pull on flexible pull-wire 15. This, in turn, pulls tapered plug 14 up inside the pear-shaped segments 6, forcing them outward so that their surfaces 7 smooth out the inside wall of the tubing.

The manual method of actuating the tool may be replaced by a hydraulic operation if desired. The operating head 5 can be made in various sizes to accommodate different diameters of tubing.

U. S. 2,423,458, issued July 8, 1947, to William Martin, Dayton, Ohio.

Tank Roof Permits Fast Drainage And Cuts Corrosion on Underside

A DECK PORTION which increases in slope progressively permits a floating roof on an oil storage tank to be rapidly and efficiently drained of rain water.

The design also maintains a wetted condition on the underside of the deck portion, thereby eliminating rapid or excessive corrosion. Such corrosion results from the accumulation of air or vapor between the deck portion and the supporting liquid when the liquid consists of "sour" or highly corrosive oil.

Fig. 7 is a diagrammatic view of the principle of operation; the vertical scale is approximately four times the horizontal scale. The symbol *A* designates the annular pontoon at the periphery of the roof, *B* the deck portion, and *C* the central circular pontoon. *X* is the level of the liquid in the tank.

Both peripheral and central pontoons are of stiff construction, while deck portion *B* is flexible metal. Water falling on cone-shaped top *I* of pontoon *C* flows to deck *B*, as does also water falling on the sloping top of pontoon *A*. Water drains off through primary drains 1 or auxiliary drains 2.

The improved construction consists of using trusses to transfer part of the weight of pontoon *A* to the rim *J* of the central pontoon, thus concentrating a heavy load or downward force on the rim, and producing a progressively increasing slope in deck *B*. This is done by means of a plurality of radial trusses, each of which comprises vertical post *F* and suitable rods *D* and *E*.

The outer edge of deck *B*, being fastened to pontoon *A* at or very near the bottom of the pontoon, helps to maintain all underside portions in a wetted condition, thus reducing corrosion.

The length of the vertical arrows *Y* illustrates the difference in magnitude of the upward force of the supporting liquid on various portions of the roof.

U. S. 2,425,771, issued August 19, 1947, to John H. Wiggins, Chicago, Ill.

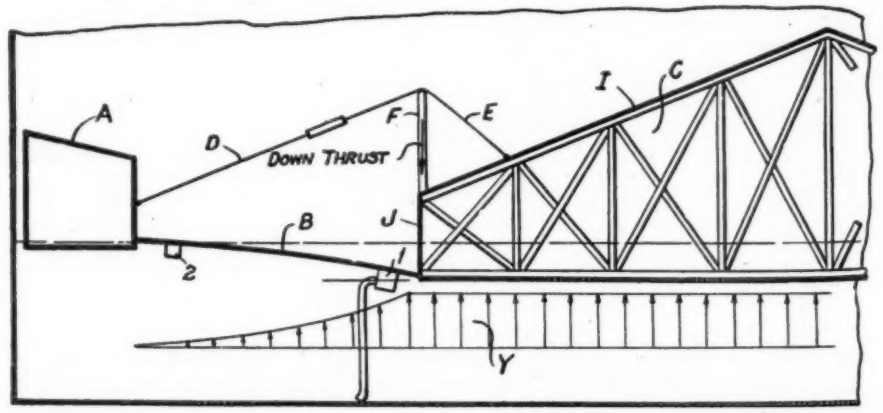


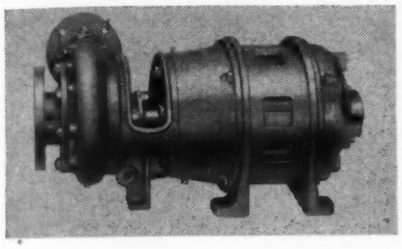
Fig. 7—More efficient rainwater drainage because of sloping deck B is claimed for this floating roof design (U. S. 2,425,771)

What's New!

Edited by
WILLIAM [illegible]
Equipment Editor

EQUIPMENT . . . MATERIALS . . . PROCESSES . . . LITERATURE

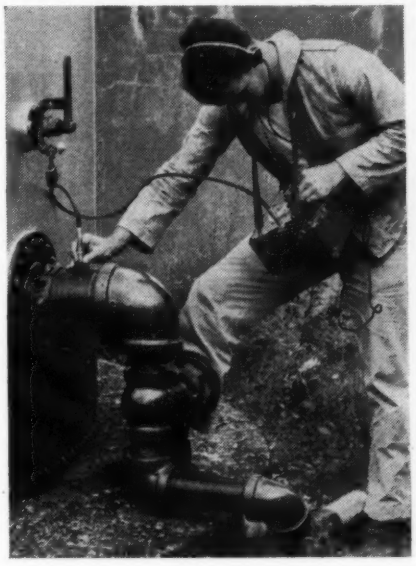
1—Centrifugal Pump



A single shaft eliminates the usual coupling and is said to assure perfect alignment with freedom from vibration in the new line of "Close-Cupld" centrifugal pumps. Motor and pump are mounted on a single, compact assembly ready to install and operate in any position except vertically with motor below pump. A machined stuffing box permits the use of either die-formed, semi-metallic packing with lantern type liquid seal ring or a mechanical seal. A number of other features are said to prevent motor and shaft from liquid damage. Available in 17 sizes with capacities up to 2000 gpm. and heads up to 400 ft. Goulds Pumps, Inc.

2—Thickness Gage

The fundamental frequency at which a wall section will resonate is directly proportional to the velocity of sound in the material and inversely proportional to its thickness. The wall thickness will also resonate at all harmonics of the fundamental frequency. This principle was used in the design of the new "Audigage" Thickness Gage, Model FMSS-4, which utilizes a crystal type gage head, powered by a frequency-modulated electronic oscillator. It produces audible signals corresponding to harmonic resonance. The frequency difference between any two adjacent audible signals as read on a tuning dial is readily converted into wall thickness on a calibrated concentric scale on the same dial. Light and portable—the unit is battery-operated—it can be applied to steel, aluminum, brass, copper, and glass and has a range of 1/8 to 12 in. Branson Instruments, Inc.



3—Packless Valves

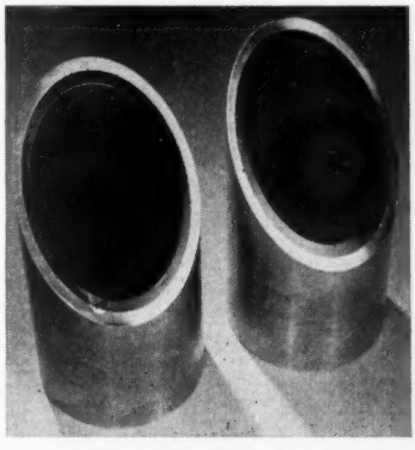
Seamless, stainless steel bellows are said to be a feature of a new line, Series 3000, of packless globe valves designed for high vacuum service. They will handle pressure conditions from less than one micron to 300 psi. and temperatures from minus 300 to plus 700° F. Fulton Sylphon Co.

4—Carbon Monoxide Tester

Utilizing indicator tubes developed by the Bureau of Standards and used by the armed forces during the war, the new MSA Carbon Monoxide Tester indicates the presence of this dangerous gas in concentrations from 0.001 to 0.10% by volume in air. Requiring no special training to operate, the instrument measures CO by a colorimetric comparison. The detector tube contains a yellow silica gel, impregnated with a complex silico-molybdate compound and catalyzed by palladium sulfate. In use, the tip of the tube is broken off and an arbitrary quantity of air is drawn through by means of the aspirating bulb. The yellow indicating chemical turns varying shades of green in proportion to the CO concentration. This discoloration is then compared with an integral revolving color scale for direct reading. Mine Safety Appliances Co.

5—Saran-lined Pipe

Saran, a plastic with good corrosion resistance to sulfuric, hydrochloric, nitric, and phosphoric acids as well as a wide range of oils and solvents, has been adapted to use as a lining for steel pipe. The working temperature of Saran-lined pipe ranges from 0 to 190° F., depending upon service conditions. Lengths up to 10 ft. and sizes from 1 to 4 in. will be manufactured, as will also fittings such as ells, tees, companion and reducing flanges, and gaskets. Conventional power tools may be used for field assembly, it is reported. Dow Chemical Co.



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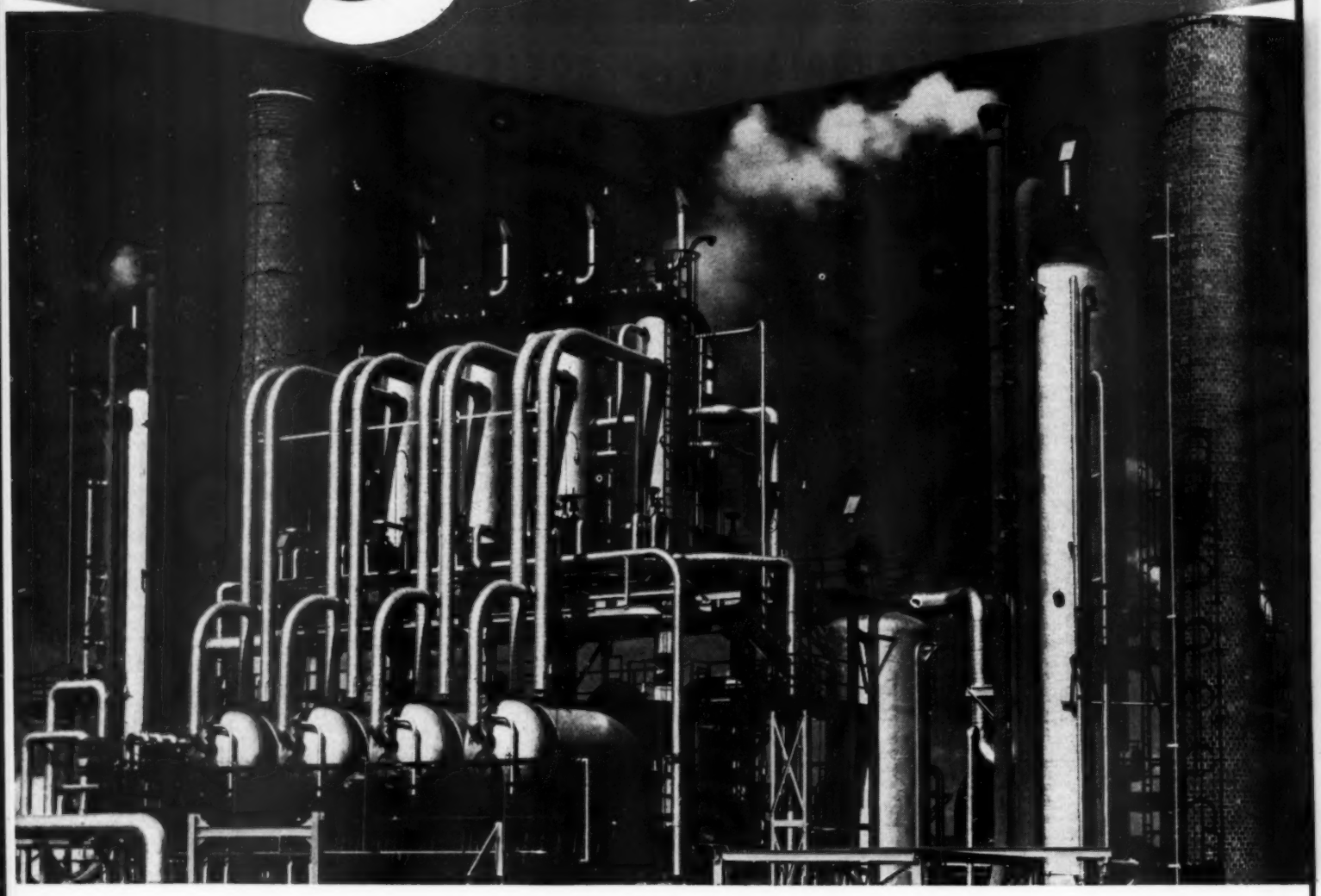
More "What's New!" Items, Page 787

ANOTHER Sampson OFFERING



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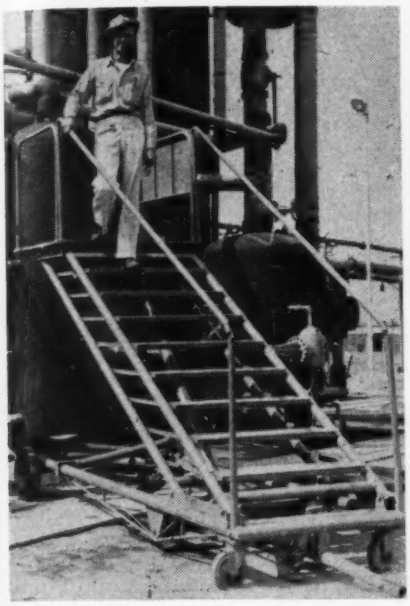
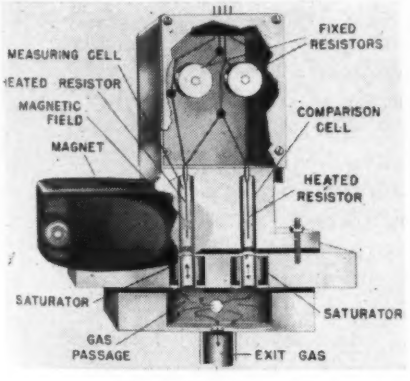
6—Adjustable Workstand



"Aerostands," hydraulically adjustable workstands, are said to be time and work savers in refinery maintenance and repairs on overhead lines, valves, etc. They provide working platform heights between 3 and 24 ft. above ground level. Steps to the platform are self-leveling at all heights. Handrails are provided on the stairway and platform. A static load capacity rating of 1500 lbs. on the platform is claimed by the manufacturer. Airquipment Co.

7—Oxygen Recorder



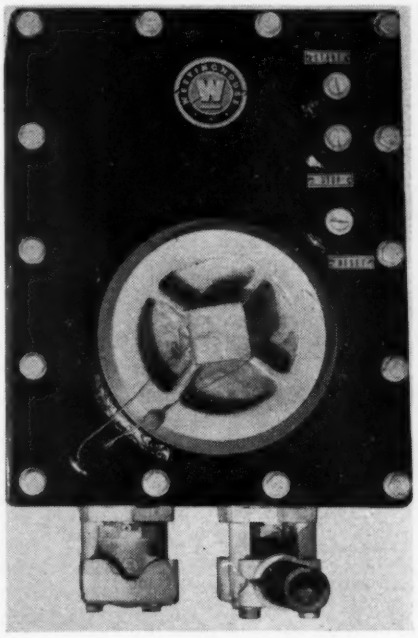
Oxygen alone among most generally-used commercial gases is attracted to a magnetic field, making possible the development of the new Hays "Magno-Therm" Electronic Type Oxygen Recorder. A hot wire resistor in the system of course limits the use of the instrument to certain applications in the petroleum refining industry. In operation, the oxygen in a gas sample stream affects the resistance of an electrically-heated wire suspended in the stream and in the center of a strong permanent magnetic field. The resistance effect is compared and measured by a Wheatstone bridge system balanced against another hot wire not in the magnetic field but in the gas stream. Overall accuracy is said to be 0.25% up to 20% oxygen and plus or minus 2½% of range up to 100%. Measuring wire is glass-coated for protection from corrosive gases. Hays Corp.

8—X-ray Photometer

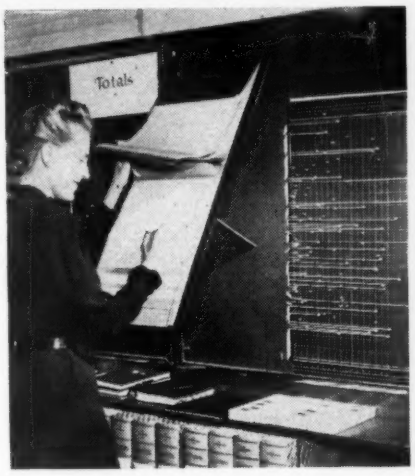
Among the new applications found for the GE X-ray photometer is the satisfactory determination of the tetraethyl lead content of gasoline. The determinations are made by measuring and comparing the X-ray absorption of a sample and a reference. In operation the instrument has handled up to six samples per hour. An advantage claimed is that determinations can be made independent of the physical state of the sample, and the device can be operated by any reasonably competent technician. It is available for manual operation, but recording and self-balancing features can be added when desired. General Electric Co.

9—Linestarter

An overload relay that can be arranged for either manual or automatic resetting is one of the features of a new explosion-tested linestarter for use with d-c motors up to 5 hp. on circuits of 80, 115, 230, and 550 volts. Other features are a magnetic contactor with knife edge bearings, packing glands that can be bolted in place permitting the assembly of conduit and gland away from the starter and then bolting the assembled unit to the starter, and a hand hole in the cover to facilitate replacing of fuses in heaters. Unit has passed Mines Bureau explosion tests and may be used on "Permissible" machines when applied in accordance with the Bureau's regulations. Westinghouse Electric Corp.

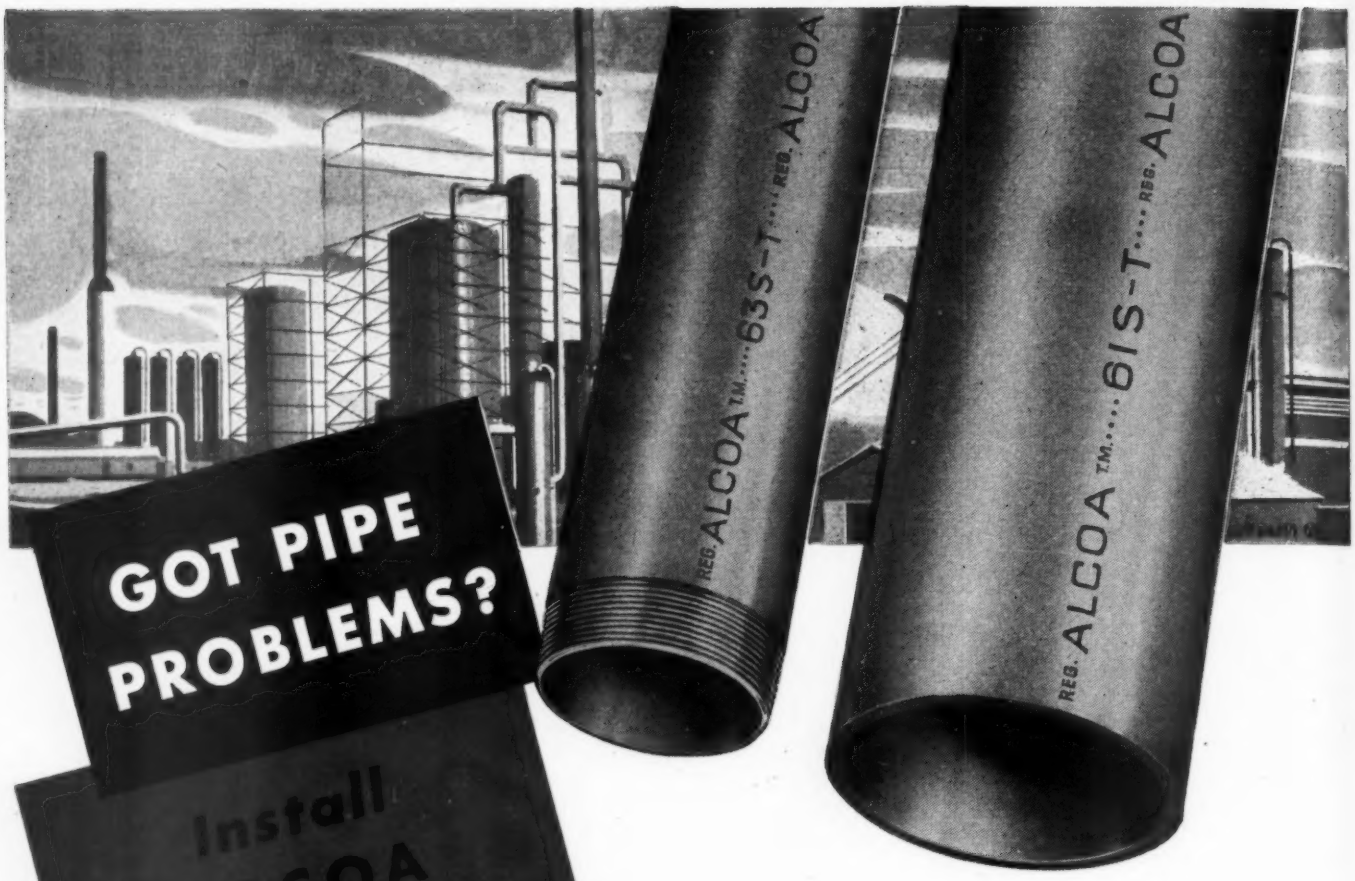


10—Control Board



A visual control board has been successfully used in the scheduling of operations of the laboratories of one large oil company. It is said to provide immediate graphic representation of a large series of operations and can be operated by an intelligent routine office worker. Permanent card records of the various elements under control are placed in pockets on the left side of the board, where there is space for 100 items. Information is indicated by pegs placed in the series of holes running horizontally across the panel from the left index section. Wassell Organization.

More "What's New!" Items, Page 789



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63S-T	35,000 p.s.i.	30,000 p.s.i.	106
61S-T	45,000 p.s.i.	40,000 p.s.i.	118

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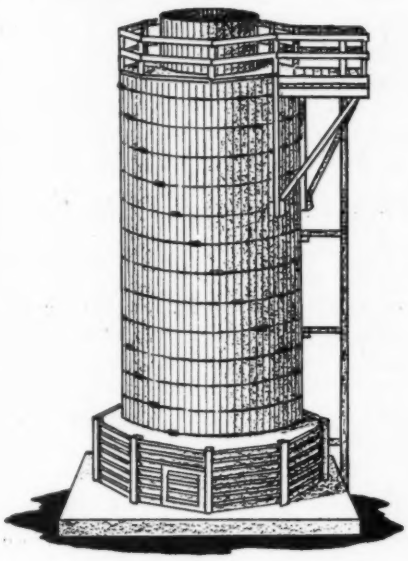
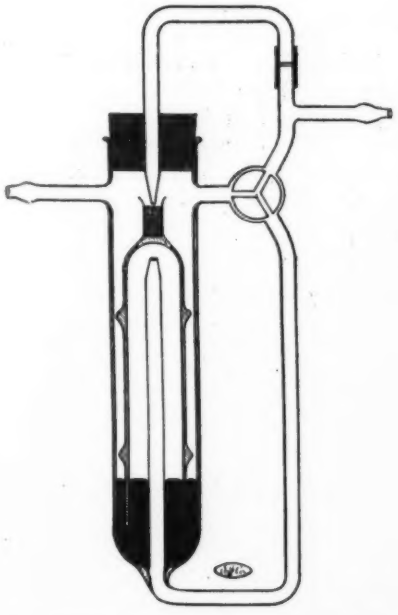
11—Cooling Tower



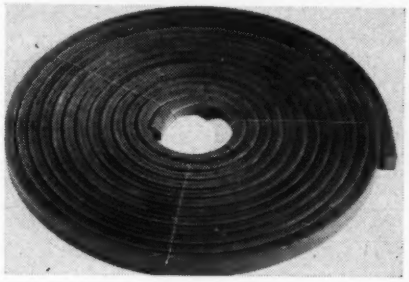
A new cylindrical cooling tower is said to eliminate dead air spaces which occur in conventional rectangular or octagonal towers. It is said that air can enter the unit from any point of the circumference, accounting for even distribution and reducing the need for baffles or diverters. The cylindrical construction also reduces the wind load on the structure. The tower can be furnished in single or double wall construction, individual or multiple-cell units, in either wood or steel. Santa Fe Tank & Tower Co.

12—Pressure Controller



An improved model of the Cartesian Manostat for obtaining reduced pressure control in vacuum distillations, vapor-liquid equilibrium measurements, etc., in the laboratory includes a number of new features. One three-way stopcock has replaced the two straight-bore stopcocks formerly used, making for easier manipulation. Increase in diameter of the float and float chamber increased the sensitivity so that any laboratory system can be held at constant subatmospheric pressures ranging from 760 to 1 mm. or less Hg. Instrument is said to eliminate all electrical appliances and additional accessories. Emil Greiner Co.

13—Vee-Belting



Open-end V-belting is now available for purchase by the foot or yard in any length required. The new method of merchandising the material is expected to simplify and reduce costs of maintenance and repairs on equipment using V-belting. Special fasteners are supplied for making belt up to any size desired. Furnished in reels of 450 to 550 ft. lengths, open-end V-belting will come in standard top widths of 21/32, 7/8, and 1¼ in. Goodyear Tire & Rubber Co.

Trade Literature

14—Floating Roofs

Wiggins Hidek Floating Roof, a 20-page booklet giving details on the construction of the Hidek floating roof for petroleum storage tanks and comparison charts on evaporation losses of various types of tanks. General American Transportation Corp.

15—Silicone Oils

Silicone Notes, Reference No. A-20-1, is a report describing the properties and service results of the DC-710 line of Silicone oils for high temperature lubrication. Dow Corning Corp.

More "What's New!" Items, Page 790

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These photographs show grease-base reactions to extreme heat. In Lime Bases, evaporation of moisture under heat causes separation of soap from oil (Photograph A). Exposed to similarly high temperatures, clear-type, anhydrous Metasap Stearate Base Greases maintain their oil-base balance (Photograph B) because they have no moisture to evaporate. Metasap also gives your lubricants the advantage of less base, more mineral oil — the true lubricating ingredient, and provides any desired degree of body from stiff, short-feathered greases to thin fluid lubricants. Write today.
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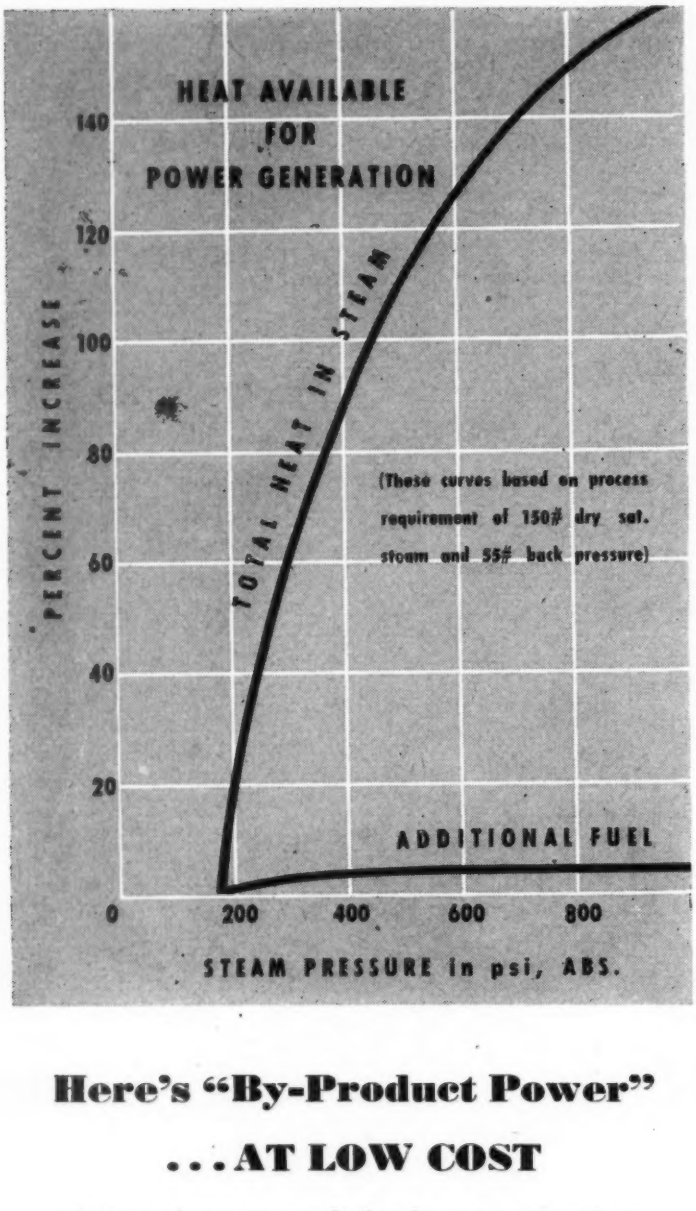

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What's New!

16—Chemical Products

General Products List, Bulletin 100, is a 20-page bulletin describing products manufactured by Hooker Electrochemical Co. Included are a number of products of use in the petroleum industry. Structural formulas, uses and shipping containers are given.

17—Corrosive Service Meters

Corrosive Service Flowrator Meters, Catalog section 32-F, is a new bulletin announcing a new line of instruments made of materials such as porcelain, hard lead, haveg, glass, hard rubber, and the like. Included are dimensional details and a section on laboratory type flow meters. Fischer & Porter Co.

18—Thickness Measurement

The Sperry Reflectogage, Data Sheet 3700, six pages of descriptive data on a new instrument for determining the thickness of metals from one side only. Sperry Products, Inc.

19—Injectors and Gages

Penberthy Products, Catalogs No. 34 and 34-A, give complete specifications, and prices on line of injectors, lubricating devices, liquid level gages, sump pumps. Penberthy Injector Co.

20—Stainless Fittings

Stainless Steel Welding Fittings, Bulletin 47-1, eight pages of data, specifications, analyses, and list prices on welding fittings of stainless steel—ells, tees, caps, and reducers. Midwest Piping & Supply Co.

21—Hydrocarbons

Phillips 66 Hydrocarbons, Bulletin 129A, and Price List, No. 5, the 1947 Supplement of data on research grade, pure, technical, and commercial grade hydrocarbons, and special purpose compounds produced and supplied by the Chemical Products Department, Phillips Petroleum Co.

22—Stainless-clad Steels

Lukens Stainless-Clad Steels, 18 pages of information, including recommended applications and tables of resistance of stainless steels to corrosion of over 100 different materials. Lukens Steel Co.

23—Tank and Vessel Lining

Lithcote Linings, a new brochure on protective baked-on synthetic resin coatings and linings for steel and other metals, said to be resistant to the action of petroleum, alcohols, solvents, fats, brines, and acids. Includes results of laboratory tests of the material. Lithgow Corp.

24—Pneumatic Controllers

Air-Operated Controllers, Catalog No. 8905, is a new issue covering air-operated control instruments for temperature, pressure, flow, liquid level, and humidity. Brown Instrument Co.

25—Butterfly Valves

R-S Butterfly Valves, Bulletin 18-B, describes a line of cast steel valves in 150, 300, and 600 lb. ranges, useful for the control and quick shut-off of oils, gases, steam, water, and chemicals, under high or low pressures and temperatures. R-S Products Corp.

26—Public Relations

Tie-In, a detailed plan book designed to help petroleum companies, oil associations, and related organizations participate in the petroleum industry's nationwide public relations program. It includes material for newspaper, radio, and mail campaigns. American Petroleum Institute, Public Relations Operating Committee.

27—Refinery Flow Chart

How an Oil Refinery Operates, an advertisement in the Sept. 27 issue of the Saturday Evening Post featured a full-color painting of a modern refinery. A 22 x 23 in. enlargement in color of this painting and the accompanying flow chart is being offered by Armstrong Cork Co.

28—Photographic Equipment

Photographic Processing Equipment describes standardized items available for the industrial photographic laboratory, including print and film processing units, temperature-controlled washers and dryers, and refrigeration units. Prices are given. Ingraham-Fisher.

29—Quality Control

Inspecting Incoming Material, a new 4-page folder on quality control suggests procedures to be followed from time material arrives until it is accepted or rejected. Includes some requirements covering a typical training course and a number of standard forms. North American Philips Co., Inc.

30—Organic Chemicals

Physical Properties of Synthetic Organic Chemicals, Form No. 6136; 12-page booklet with data on applications and physical properties of over 175 synthetic organic chemicals, presented in tabular form. Carbide and Carbon Chemicals Corp.

31—Furnace Heat Losses

Heat Losses in Furnace Linings, Bulletin 3-404, a reprint of an article under the same title giving simplified methods for determining the efficiency and economics of various types of refractory linings for industrial furnaces. Babcock & Wilcox Co.

32—Temper Designations

Alcoa Temper Designations for Cast and Wrought Products, presents a revised system of aluminum alloy temper designations which will become effective on all Alcoa shipments made on and after January 1, 1948. Aluminum Co. of America.

33—Recording Gages

Bristol Series 500 Recording Gages and Thermometers, Bulletin T835. A 16-page bulletin of information on the Series 500 recording thermometers and pressure gages. Bristol Co.

34—Diaphragm Motors

Characteristics of Pneumatic Diaphragm Motors, Bulletin No. 101, an eight page report covering information for determining force requirements, proper sizes, proper application, accuracy of regulation, and a review of the fundamentals of this type of equipment. Conoflow Corp.

35—High Temperature Valves

Kerotest Stainless Alloy Valves, No. 47-AS, a four-page booklet including a specification guide for buyers of valves for corrosive, high temperature, and high pressure service. Kerotest Mfg. Co.

36—ASA Standards

ASA Standards, Price List, No. 4702, August, 1947, is now available. It includes prices which have been revised upward because of increased production costs, it is said. Also included are a number of revised standards approved since the January, 1947 issue. American Standards Association.

For Your Convenience

Business reply cards are included in this issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing page 785. Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the bottom of the card, and drop it in the mail. No postage required.

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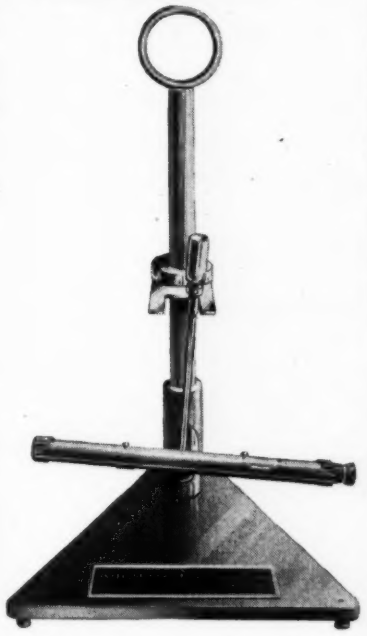

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Control and Operation of De-ethanizers

By A. J. L. HUTCHINSON
The Fish Engineering Corp., Houston

Close control of a de-ethanizer in the production of propane from natural and refinery gases is obtained by several means. Propane losses are held to a minimum by maintaining a constant temperature at reflux condenser and returning all reflux to the column. Temperature at reflux, however, must be held above point where ethane will be forced into the bottoms product.

Control of reboiler temperature is required to remove all propane possible from bottoms. Constant heat input to reboiler will then automatically result in correct amount of reflux and bottom temperature. The minimum amount of heat to introduce can be determined by changing heat input to reboiler with a constant feed quantity and degree of vaporization at the feed tray, and observing the reboiler temperature.

Degree of feed vaporization, to prevent overloading the bottom of the tower, is best controlled by flow rate rather than temperature.

Smooth de-ethanizer operation is secured through efficient layout and design, and selection of proper pumps for reflux.

THE art of fractionation is old but many new applications have been introduced in the past few years. In the petroleum refining industry this art has been developed to a high degree to produce pure hydrocarbons and specialty products. A number of plants are using large scale fractionating equipment to produce fractions with a maximum of 1° F. boiling range.

The first application of sharp fractionation to the natural gasoline industry was in the "stabilizers" installed to produce a specified vapor pressure product, or a product with a maximum specified distillation loss. The first successful "stabilizers" were the low pressure, low temperature type. These were followed by the high pressure type. In these latter stabilizers it was attempted at first to control both the bottom and top temperatures at the same time with very unsatisfactory results. In about 1924 the first really successful stabilizer was installed, using bottom temperature control and a constant volume of reflux.

This type of operation was continued for a number of years with practically no change. With the development of the LPG market and other uses for the propane and butane content of natural and refinery gases, columns to produce these products were installed and new methods of control developed to meet the needs of changing markets. To produce pure propane or liquefied petroleum gas (LPG) with a specification vapor pressure it is necessary to remove substantially all of the ethane and methane. This has led to the development of a special type of control, resulting in a de-ethanizer becoming a special case of fractionation in the natural gasoline industry.

The primary object of a de-ethanizer is to strip out of the feed stock substantially all the ethane and to retain in the column bottom product as much of the propane and heavier constituents as possible. As the temperature and pressure in the reflux accumulator of the column determine the propane content of the waste gases, the tendency has been to run these columns at as high a pressure as possible. There are two limitations on the maximum pressure that can be used. (1) Temperature of the bottoms must be high enough so that the vapor pressure of the bottoms equals column operating pressure. (2) Pressure must not be so high that excessive reflux is encountered or an excessive number of plates required.

The latent heat of any constituent or mixture decreases as the temperature is raised and ultimately falls to zero at the critical temperature. From this it can be easily seen that, as the pressure of the column is raised, of necessity the bottom temperature increases also. This then increases the vapor rate at the base of the column for a given heat input, requiring a larger column to handle the load.

In any column the ease of separation of any two adjacent components of a mixture, such as ethane and propane, is a function of the ratio between the equilibrium constant, K_1, of the lighter component divided by the equilibrium constant, K_2, of the heavier; the larger this ratio the easier the separation. As temperature and pressure increase this ratio decreases, thereby requiring more reflux, additional plates or both. For any given separation the temperature at the top of the column increases as pressure increases and the same condition is created there as in the base of the column. In most natural gasoline plants this means limiting the pressure to about 500 psig.

Controlling Propane Losses

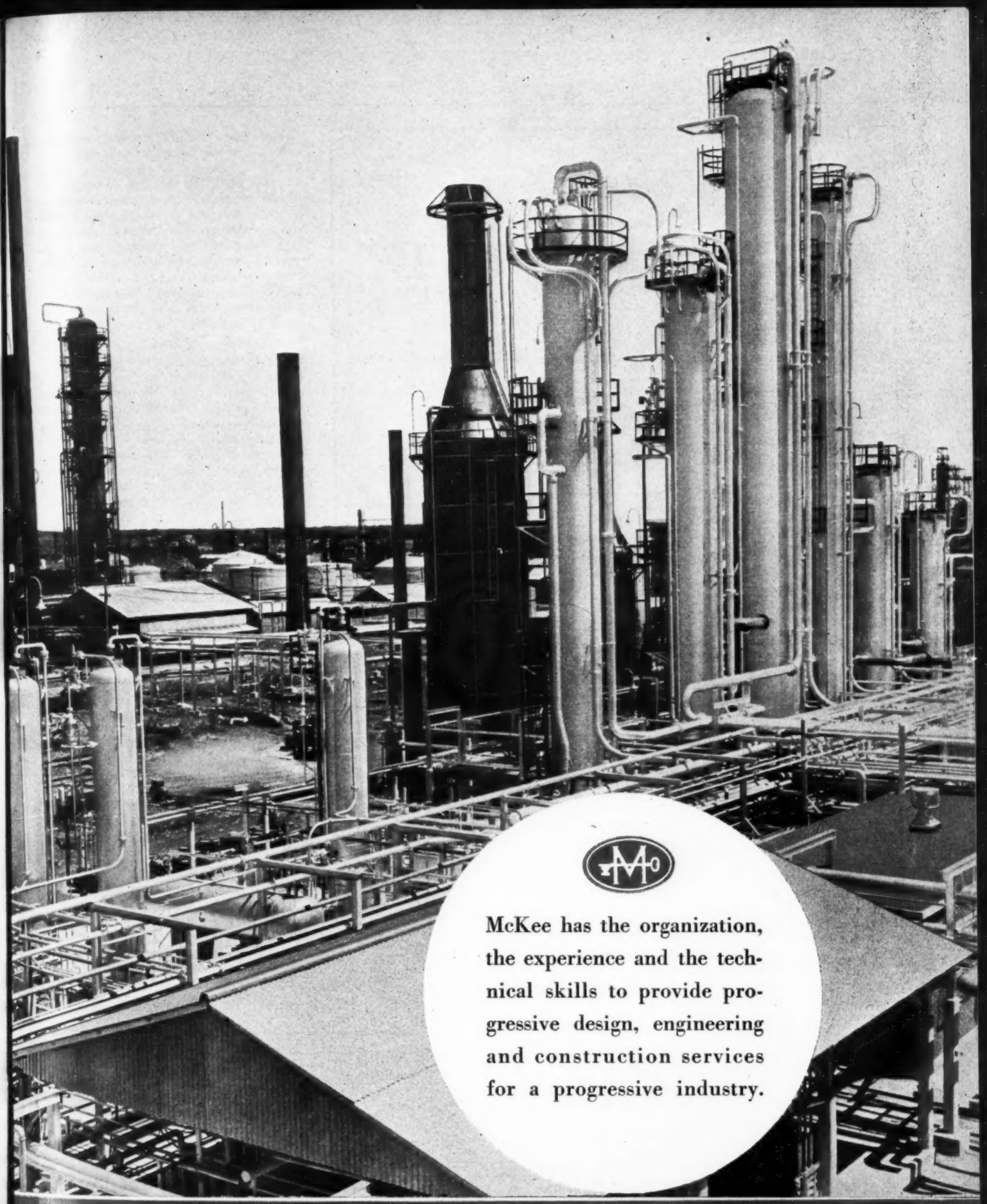
With a water cooling of the reflux condenser the propane loss will vary with the cooling water temperature. To reduce the loss of propane, refrigeration can be used to reduce the temperature of the reflux condenser and, by holding a constant temperature at this point, propane loss can be held to a substantially constant and low value.

The reflux with normal water cooling consists of a mixture of methane, ethane and propane. At any given operating pressure and reflux condenser temperature this composition is fixed by the feed analysis provided enough heat is introduced to the reboiler to strip out the ethane. Then as the reflux condenser temperature is lowered this lower temperature reflux lowers the column top temperature, reducing the amount of propane passing overhead into the reflux condenser. This in turn reduces both the propane content of the reflux and waste gases.

The practical limit of temperature reduction that can be used in the reflux condenser is reached when the amount of propane passing overhead is very small. If the temperature is further reduced the reflux will consist solely of methane and ethane and the column top temperature may become so low that not all the ethane can pass overhead. When this condition exists, ethane is forced into the bottom product.

With the loss of propane fixed the propane content of the bottoms must vary as the composition of the feed varies. It is customary in fractionation to maintain a constant pressure on the column. As the bottom temperature of the column is a function of the composition of the bottoms product the bottom temperature must vary. This variation in bottom temperature may be due to varying amounts of other constituents besides propane. Therefore the control system used must be designed to take care of these conditions.

Fig. 1 shows a tested and satisfactory control method. The feed enters the column through a feed preheater. This preheater may consist only of heat exchange with bottoms product, a steam heater alone or a combination of both. The subject of feed preheat will be discussed



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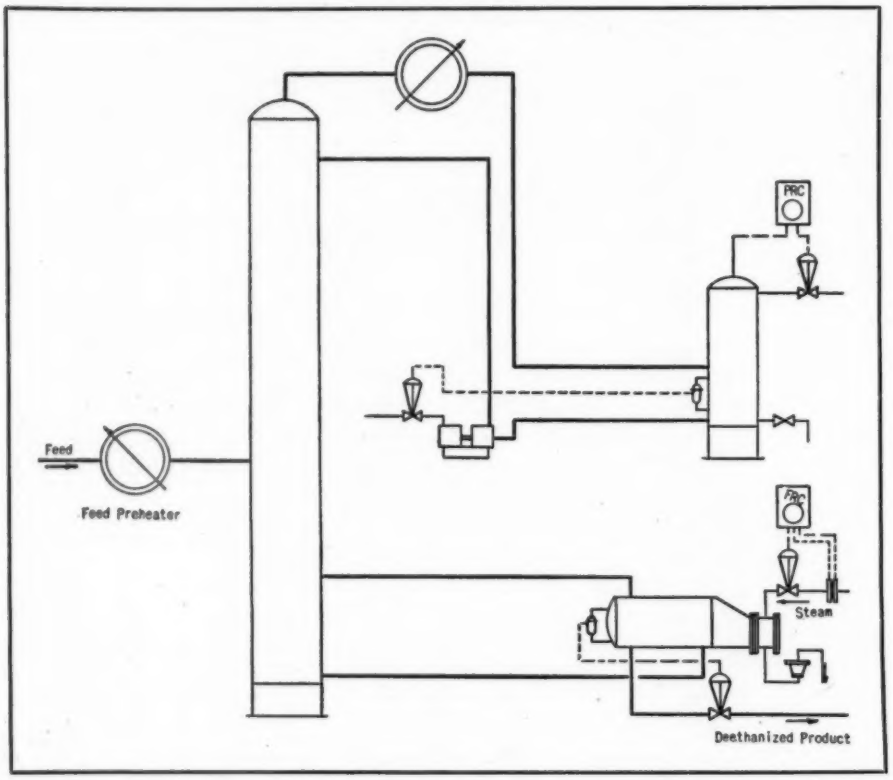

Fig. 1—Flow diagram of de-ethanizer, showing method of reflux and reboiler control for minimizing propane losses

later. The vapors overhead pass through a reflux condenser to a reflux accumulator where the total liquid condensed is pumped back. By this method of operation the minimum propane loss results, since the total propane loss is that carried out with the vapors.

In order to permit all the retained propane to leave as a bottoms product and not build up in the column, and at the same time strip the bottoms of ethane, the bottom temperature must be exactly right. With a constant heat input to the feed, a constant heat input to the reboiler will automatically result in producing the correct amount of reflux and bottom temperature. This presupposes that sufficient heat is introduced into the reboiler to generate the required vapors to properly strip in the bottom part of the column.

In this method of control the minimum amount of heat to introduce can be determined by changing the heat input to the reboiler, with a constant feed quantity and degree of vaporization at the feed tray, and observing the reboiler temperature. With insufficient heat input, upon increasing the heat input rate, the bottom temperature will rise and with added heat continue to rise until all the ethane is stripped and then remain constant. This is because after all the ethane is stripped out the composition of the bottoms remains constant. The additional heat added is absorbed in the reflux condenser and, with the method of control shown, results in increasing the reflux rate. In this it is assumed the reflux condenser is of sufficient size so that the increased heat load does not increase reflux temperature.

One cause of trouble in de-ethanizers, especially where refrigeration is used on the reflux condenser, is due to water in the feed. The top temperature of the column will not permit much water to pass overhead and the bottom temperature will not allow water in the bottoms product. Water may build up in the column to such an extent that a "puking" condition results, or at least very unstable operation is encountered.

Preventing Pump Vapor Lock

The reflux pump on a de-ethanizer is likely to give trouble unless certain precautions are observed. The reflux is far lighter than that encountered in other columns so the net positive suction head (N.P.S.H.) on the pump must be high. In most cases the reflux is below atmospheric temperature. As a result of this, a very small rise in temperature of the reflux between the reflux accumulator and the pump will result in gas binding the pumps. This can of en be overcome by insulating the reflux pump suction line, subcooling the reflux between the pump and accumulator, or both.

In pumping all very light liquids the accumulators should be located well above the pumps, with excessively large suction lines as free as possible of fittings to reduce pressure drop to a minimum. To further reduce the possible vapor content of the feed and possibility of vapor binding the pumps, a vapor trap may be installed just ahead of the pumps with the suction line from this trap to the pump as short as possible.

This trap consists of a piece of pipe, usually about double the diameter of the suction line, capped at both ends, set in a vertical position and extending a foot or so above the liquid level in the accumulator. The bottom of this pipe is below the suction connection on the pump. The liquid enters on one side and leaves on the opposite side at the same elevation, which is the suction connection elevation on the pump. Between the inlet and outlet connections a vertical baffle, double the inlet pipe size in length and centered on the inlet pipe, is placed diametrically across the trap at right angles to the center line of the inlet and outlet nozzles. The top of this standpipe is vented back to the accumulator. In this way any vapors generated in the line between the accumulator and this trap rise through the liquid and return to the accumulator. Usually this standpipe trap should be insulated.

Due to the high suction pressure and low head on the pumps either a simplex pump with tail rod or mechanically sealed centrifugal pump is recommended. If a simplex pump is used it should be run at a low piston speed and equipped with very light suction valves. In a number of cases pump trouble has been elim-

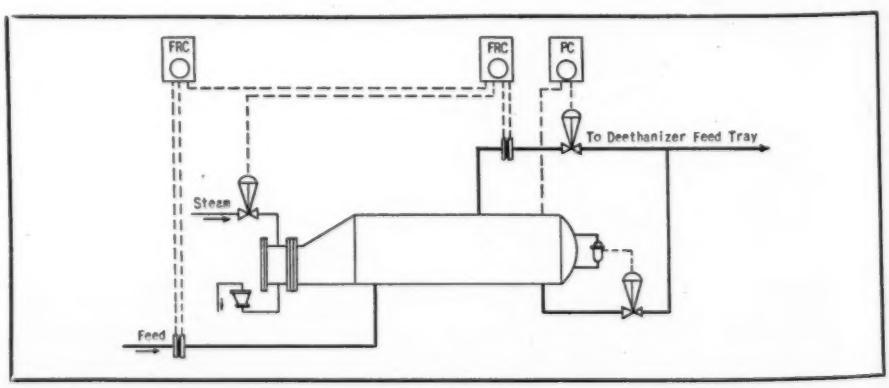

Fig. 2—Feed preheater control system to provide constant feed vaporization by flow rate controlers. This system permits more variations in feed rate and composition than most, does not depend on temperature

inated by removing the springs from the suction valves.

Feed Vaporization Control

The percentage of feed in the vapor state entering the column is very important. If the percentage of vapors is too great the top part of the column will become overloaded before sufficient heat can be introduced into the reboiler to provide the vapors necessary for stripping. If the feed is not sufficiently vaporized the bottom part of the column may become overloaded. In general the percent of feed in the vapor state entering the column should be from seven to eight-tenths of the percent of the feed overhead, on a molal basis.

At the temperature and pressures used in de-ethanizers, control of the percent vaporization of the feed by temperature control is very difficult. A small change in temperature makes a big difference in percent vaporization. A case is known where a 5° F. increase in feed temperature changed the vaporization from 5% to 24%. Likewise, a small change in feed composition will make a large change in the percent vaporization. It is therefore advisable to provide a different method for control of feed vaporization. Fig. 2 shows such a method.

The feed enters a kettle type heater through a flow rate controller. This flow rate controller resets a flow rate controller in the vapor line from this heater, which later controls the steam input to the heating coils. By proper selection of orifice plate sizes and scale ranges on the flow control instruments, any degree of feed vaporization can be maintained. The heater must be operated at a slightly higher pressure than the column in order to force the liquid portion of the feed through the liquid level control valve and lift it into the column. This pressure should be as little above column pressure as possible in order to avoid a large flash of the feed in passing through the liquid line control valve.

In all fractionation work it is well to keep feed rate and feed composition as constant as possible. The method of control just described will permit far greater variations than most others, provided that heat input to the reboiler is always maintained slightly greater than minimum for maximum feed rate. It is not recommended that the heat input be varied either manually or automatically with changing feed rate or composition, as to do so may cause the column to surge or otherwise show unstable operation.

The points and methods of control discussed above appear, and are, rather simple in application. However, like so many other simple things, they are very important to smooth de-ethanizer operations and are often overlooked. No attempt has been made here to go into detail, since varying conditions from plant to plant will require certain alterations best decided upon in the field.

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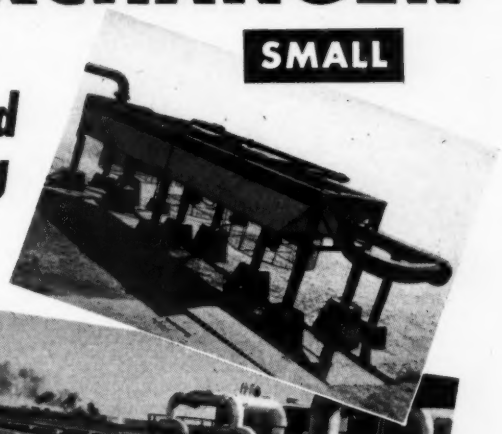

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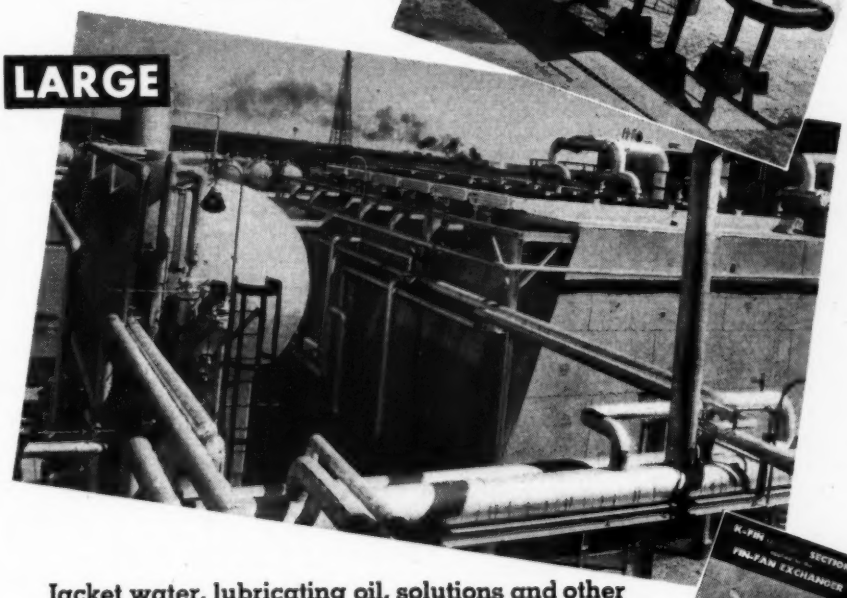

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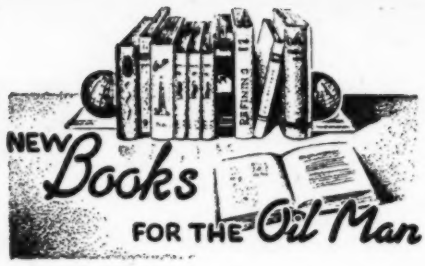

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Volume on Colloids Is Based On Cambridge Lecture Series

Colloid Science, 5½ x 8½ in., 218 pages, stiff cloth cover, indexed, $6.00.

Chemists, physicists, and technical workers of many industries will find *Colloid Science* an invaluable aid in obtaining an intimate knowledge of the latest progress in the science of colloid chemistry.

The text is taken from a series of lectures given as a post-graduate course in colloid science at Cambridge University, England, under the auspices of the Royal Institute of Chemistry. The book deals with disperse systems and gives interpretations of phenomena encountered in surface films and interfaces.

Among the important topics discussed are: phases and phase changes in monolayers, multilayers, emulsion stability, adsorbed films at the solid-liquid interface, and identification of bonds and structural units by infra-red spectra. The eleven chapters have been written by various British scientists.

Third Volume in Series on Oil Production Now Off the Press

Petroleum Production, Vol. III, Oil Production by Water, by Park J. Jones, 6 x 9 in., 271 pages, stiff cloth binding, illustrated, indexed, $5.00.

This third in Mr. Jones' series on production of petroleum, just published, deals with oil production by water, and is limited to that subject. Primary gas caps and oil production by gas are not considered. The principal factors involved are: convergence, fluid factors, invasion factors, displacement factors, and well interference factors.

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The technical information given in this volume, as in the previous two dealing with the mechanics of production and the calculation of optimum producing rates, should be primarily of interest to oil men in the producing end of the business. Author Jones is a well-known Houston consulting engineer.

Second English Edition of Karrer's Text Now Available

Organic Chemistry, 2nd English edition, by Paul Karrer, translated by A. J. Mee, 6⅝ x 9¾ in., 973 pages, indexed, stiff cloth binding, $7.50, (1946).

This second Engish edition of Karrer's text on organic chemistry is based on the eighth German edition of 1942, and is the first since 1938, when a volume based on the sixth German edition was published in this country.

It is considerably revised and enlarged to include much of the German knowledge of organic chemistry up to 1942. The very comprehensive treatment includes some 75 chapters, broken up into four parts—aliphatic compounds, in 6 separate sections; carbocyclic compounds, both aromatics and alicyclics; heterocyclic compounds, the simpler types and the alkaloids; and compounds with heavy hydrogen and heavy oxygen.

Of interest is a table in the appendix of important dates in the history of organic chemistry. It begins with Cadet's preparation of cacodyl from potassium acetate and arsenious acid in 1760, and includes the works of Priestley, Sheele, Gay-Lussac, Berzelius, Kekule, Perkin, Dergius, Urey, Carothers, and many others.

Author Karrer is professor of chemistry at the University of Zurich, Translator Mee is head of the science department, Glasgow Academy.

Importance of Aliphatics Noted In Groggins' Third Edition

Unit Processes in Organic Synthesis, 3rd Edition, by P. H. Groggins, 6 x 9 in., 931 pages, stiff cloth binding, indexed, $7.50

The new third edition of this pioneer text, *Unit Processes in Organic Synthesis*, is a complete revision of preceding volumes, being brought up to date with emphasis on increased production and importance of the aliphatics. Considerable new material has been added, relating largely to the wartime development of chemicals which enter the production of aviation fuels, solvents, chlorinated hydrocarbons, surface active agents, plastics, and synthetic elastomers.

Dr. Groggins points out in his preface that the remarkable growth in the chemical industry can be attributed largely to the fact that petroleum and natural gas have displaced coal as the principal source of basic chemicals for organic synthesis. Thirty new flow diagrams have been incorporated.

Of especial interest is the introduction of an appendix containing charts showing the diverse products obtainable from petroleum hydrocarbons. The chapter on polymerization has been completely rewritten by Professors W. P. Hohenstein and Hermann Mark of the Institute of Polymer Research, Brooklyn Polytechnic Institute. Dr. Mark has for many years been recognized as one of the country's foremost authorities in the field of high polymers.

Editor-in-chief Groggins is a chemical engineer with the Department of Agriculture, and author of several books on organic chemistry.

Bureau of Mines Publishes 1945 Minerals Yearbook

Minerals Yearbook, 1945, edited by H. D. Keiser, U. S. Bureau of Mines, 5¾ x 9 in., 1693 pages, stiff cloth binding, $4.00. (1947)

Minerals Yearbook, 1945, is the latest complete volume of information published by the Bureau of Mines covering all phases of minerals production, consumption, demand, prices, and government activities. In addition to the usual sections devoted to a general summary, metals, nonmetals, and mine safety, there is a new part V, on foreign minerals, which was initially incorporated in the 1944 edition last year.

Reconversion to prewar scope and coverage was the principal objective in compiling the book, according to Editor Keiser in the introduction. Success in this respect, it said, can be attributed to the removal of practically all protective security restrictions on the publication of such statistics, and to the detailed information contained in reports submitted by military Government officials in occupied countries and by mineral specialists serving as U. S. representatives in other countries.

Book on SMO Process Reveals Holland's Wartime Research

The Wet Purification of Coal Gas and Similar Gases by the Staatsmijnen-Otto Process, by H. A. J. Pieters and D. W. van Krevelen, 5⅞ x 8¼ in., 55 pages, paper binding, $1.25, (1946).

Although not directly concerned with problems of the petroleum industry, *The Wet Purification of Coal Gas and Similar Gases by the Staatsmijnen-Otto Process* (SMO), is of interest because it tells something of the progress in science made in Holland during the five years of Nazi occupation.

The book is part of a set of 24 Monographs on the *Progress of Research in Holland during the War* covering many phases of technical endeavor. Printed in the Netherlands, it is in English. Reproduction of chemical and mathematical symbols, flow diagrams, charts, and the like, as well as general typography is excellent.

The editors of the series, in a foreword dated May 8, 1945—V-E Day—explain that it was their aim to present the series as early as possible after the war and therefore the majority of them were prepared during the conflict. The authors were therefore expected to give mainly the results of their own investigations without particular reference to recent Anglo-Saxon literature.

Authors Pieters and van Krevelen are members of the staff of the Central Laboratory of the Netherlands State Mines.

PERSONALS

Petroleum Technologists in the Headlines

With the transfer of **R. L. Johnson,** superintendent of Sunray Oil Corp.'s refinery at Santa Maria, Calif., to Duncan, Okla., where the company is opening its recently purchased $14-million plant acquired in a sale by WAA, **E. D. Ford,** Mr. Johnson's assistant at Santa Maria, has been advanced to superintendent. Mr. Ford is in charge of crude oil purchases, pipeline and refining operations.

Mr. Johnson was called to Tulsa general offices of Sunray Sept. 1, as special assistant to **F. L. Martin,** vice president in charge of refining, to aid in expediting a remodeling and expansion program at the Duncan plant. Mr. Johnson built the original Oil States refinery at Allen, Okla., in 1921, and was formerly superintendent there when Sunray bought the property in 1929. He was transferred to head the Santa Maria plant when this unit was acquired by Sunray in 1946.

* * *

Mr. Carpenter

Mr. Matthews

Mr. Morris

Mr. Fisher

P. G. Carpenter is chief of the Production Research Section of the Physics Division of the Research Department of Phillips Petroleum Co., Bartlesville, Okla. under a recent reorganization. He graduated from Willamette University in Oregon and received his PhD degree at University of Wisconsin. He was formerly with Hercules Powder Co.

T. A. Matthews is in charge of Reservoir Engineering for the Production Research Section. He is a graduate of University of Arkansas and received his MS degree there. He has since been in reservoir work for Phillips.

W. L. Morris is in charge of Production Physics for the section. He is a graduate of Carnegie Institute of Technology, took post-graduate work at University of Pittsburgh and Duke University, receiving a PhD in mathematics from the latter. He was formerly with Gulf Research & Development Co. and Kuwait Oil Co. and during the war served as a Naval Aviation Electronics officer.

H. B. Fisher is in charge of Production Chemistry for the section. He graduated from Antioch College in Ohio and received his PhD from University of Illinois. He was formerly with Aluminum Co. and the Darce Corp.

* * *

John E. Kilpatrick, formerly with the National Bureau of Standards, Washington, who for the past few years was assigned to the American Petroleum Institute Research Project 44, has taken a position as assistant professor in Rice Institute, Houston. He will be in charge of construction of a calorimetric laboratory.

* * *

Arthur S. Randak is assistant to **C. M. Larson,** New York, chief consulting engineer for Sinclair Refining Co., taking the place of **Rene J. Bender,** who recently left for Addis Ababa, Ethiopia, as assistant to the president of Sinclair Petroleum Co.

Mr. Randak graduated from Purdue as a mechanical engineer in 1934. For a short period he worked on the design, operation and maintenance of Diesel streamlined trains for the Union Pacific. From 1937 to 1942 he was with Sinclair Refining as a Diesel engineer and then went into the Chemical Warfare Service of the Army. Transferred to the Engineers Corps, as a captain he organized a shop battalion to service Diesel locomotives transporting supply trains across Egypt and Libya in support of the British army. He was made a major in the Ordnance section and later, as a lieutenant colonel in the Air Force, helped organize the automotive ground forces in England for the 9th Air Force. He returned to the U. S. as a colonel to work on the evaluation of German aeronautical research and development. He was reinstated with Sinclair in March, 1947.

* * *

Joseph K. Roberts, general manager of research for Standard Oil Co. of Indiana, has been elected to the board of directors. He joined the company in 1928 and has served in various capacities in its research and development department.

Mr. Alcorn

Mr. Fitzgerald

Irwin W. Alcorn, Pure Oil Co., Houston, has been elected chairman of the Petroleum Division, American Institute of Mining and Metallurgical Engineers, and with other new officers will be installed at its annual meeting in New York in February.

Mr. Alcorn is a native Ohioan and obtained degrees in mining engineering from Missouri School of Mines and Massachusetts Institute of Technology. He was with Smith Separator Co. and Oil Well Supply Co. and joined Pure Oil in 1935, where he is chief production engineer for the Gulf Coast region.

Paul E. Fitzgerald, Dowell Inc., Tulsa, and **Carlton Beal,** consulting petroleum engineer, Los Angeles were elected vice chairmen of the Petroleum Division. **Benjamin C. Craft,** head of the department of petroleum engineering at Louisiana State University, was elected to its executive committee.

* * *

R. V. Safford has been appointed to the staff of the Research and Development Division of Pittsburgh Consolidation Coal Co. and will be in immediate charge of its coal gasification pilot plant at Library, Pa. He received his B.A. in chemistry from Cornell in 1937 and his degree in chemical engineering from Yale in 1939. For the past four years he has been with Stanolind Oil & Gas Co. in charge of construction of its Synthol pilot plant at Tulsa.

Thomas G. Reynolds was appointed chemical engineer on coal gasification for the coal company. He received degrees in civil and chemical engineering from the University of Illinois and his experience includes four years with Continental Oil Co., five years with Foster Wheeler Corp. as process and project engineer, together with war experience on the atomic bomb project.

* * *

Dr. Fred C. Lindvall has been elected a director of Consolidated Engineering Corp., Pasadena, Cal. He is a professor of electrical and mechanical engineering and chairman of the Division of Civil and Mechanical Engineering and Aeronautics at California Institute of Technology.

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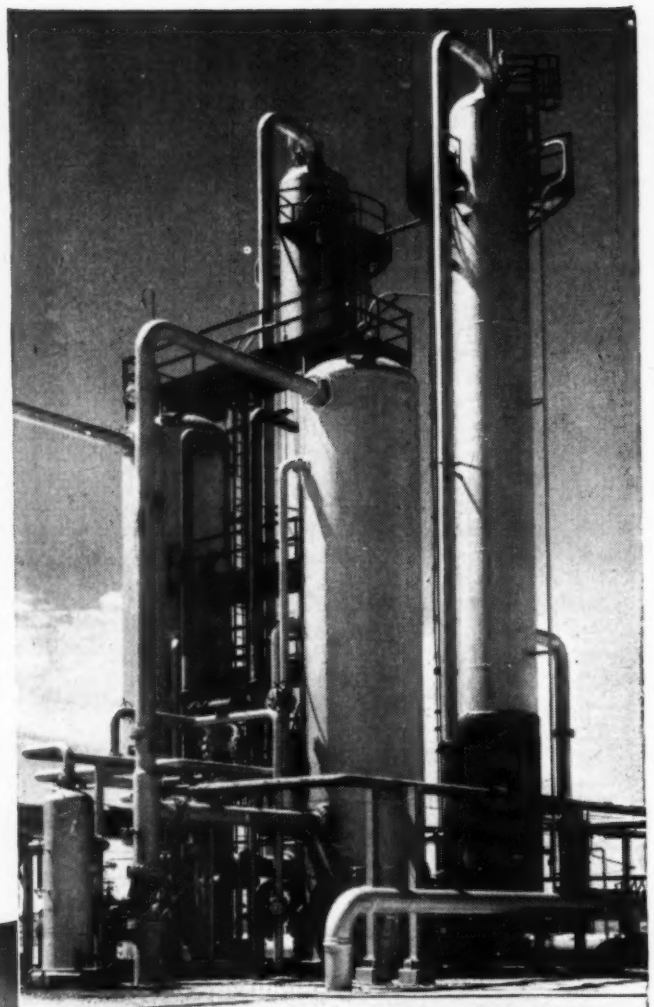

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Personals

Col. J. C. Raaen is general manager of Universal Oil Products Co. laboratories at Riverside, Ill. He has spent 29 years in the Armed Forces where he was actively associated with all phases of research and development work affecting the Ordnance Branch.

A native of Minneapolis, Col. Raaen attended St. John's Military Academy in Wisconsin and graduated from West Point in 1918 and obtained his B.S. degree from Massachusetts Institute of Technology. After graduating from various of the Army schools and doing special work for the Ordnance Dept., including supervision of construction of plants devoted to manufacture of arms and ammunition during the recent war, he was made Commanding officer of Watervliet Arsenal, Watervliet, N. Y. He has been awarded the Legion of Merit and Distinguished Service Medal.

C. G. Gerhold, formerly manager of UOP Riverside laboratories, has been transferred to the Administrative Dept. as assistant to **Edwin F. Nelson,** vice president, where his duties will be the coordinating of all research and technical activities of Universal.

° ° °

J. M. Evans is chief engineer and chairman of the board of engineers of Standard Oil Co. of California, succeeding **H. H. Hall,** who is now a director and vice president of Trans-Arabian Pipe Line Co. and will continue with California Standard as consulting engineer. Mr. Evans graduated from the University of California in 1915 with a B.S. degree in civil engineering, and immediately went to work for the California Standard, holding a number of positions before he became assistant chief engineer in 1944.

° ° °

Paul M. Waddill, manager of the licensee service section of Phillips Petroleum Co.'s chemical engineering department, has been appointed to act as liaison agent for Phillips' refining department with other refiners. He graduated from Oklahoma A. & M. College in 1931 with a B.S. degree in chemical engineering and joined Phillips in 1934.

° ° °

J. H. Osmer is secretary of California Research Corp., Standard of California subsidiary, to succeed **O. S. Loud,** who will devote his time to duties as coordinator of patents and infringement. Graduating from Princeton in 1921 Mr. Osmer joined Standard as a pressure still fireman. Six years later, after service in the chemical laboratory and research division, he was transferred to the patent department.

Mr. Loud started with the company 27 years ago as an analytical chemist at the Richmond refinery and later was assigned to the patent department as assistant to the patent counsel. He was elected secretary of the research division in 1945.

H. **Hugh Willis** is Director of Research and Development of Kellex Corp., the atomic bomb subsidiary of M. W. Kellogg Co. He was formerly chief research director and vice president of Sperry Gyroscope Co., Inc., and vice president for engineering and product development of Eversharp, Inc. During the war he was a member of the Radar section of the National Defense Research Committee. Mr. Willis will have charge of all Kellex research and development on nuclear energy and will assist in certain phases of guided missiles development.

Mr. Willis

* * *

Dr. Samuel D. Koonce has joined the sales department of Jefferson Chemical Co., Inc., subsidiary of The Texas Co., and will be engaged in market research and liaison work between the sales and technical and research departments. He was formerly with the research division of Distillation Products, Inc.

* * *

Six new assistant directors—all veteran members of the staff—have been named for Battelle Memorial Institute, Columbus, O., to be top coordinators of technology for its various research projects. Among the six: **Dr. Frank C. Croxton,** who formerly headed the Institute's chemical research, has been associated with Battelle since 1939, prior to which time he was for 9 years a member of the technical staff of Standard Oil Co. of Indiana; **Ralph A. Sherman** has been in charge of its research in fuels technology since 1930, prior to which he was with the U. S. Bureau of Mines.

* * *

Edward F. Everett, Jr., has joined the Marshall-Moorman Development Co., New York, specialists in applications of Fluid catalyst technique. He received his Bachelor's degree and a Master's degree in chemistry from Massachusetts Institute of Technology and has since been a chemical process engineer with M. W. Kellogg Co. and recently has been active in process development and design of the Fischer-Tropsch method of producing synthetic gasoline.

Mr. Everett, Jr.

M. G. Paulus, vice president in charge of manufacturing, Standard Oil Co. of Indiana, has been made vice chairman of the general committee of the API Division of Refining, and **A. F. Frame,** Petroleum Advisers, Inc., secretary. **Clarence H. Thayer,** Sun Oil Co., has been substituted on the committee for **Arthur E. Pew, Jr.,** Sun Oil Co.

Henry Paulson, The Norwalk Co., Los Angeles, has been added to the Automotive Research Committee of the Refining Division. **L. L. Davis,** Continental Oil Co., has been substituted for **H. G. Osborn,** and **J. Bennett Hill,** Sun Oil Co., for **Arthur E. Pew, Jr.**

P. S. Nisson, Pure Oil Co., has been added to the Committee on Disposal of Refinery Wastes. **W. H. Barcus,** Sun Oil Co., is alternate for **W. E. Soden.** Substitutions on this committee are as follows: **J. O. Ciprico,** Standard Oil Co. of California, for **R. W. Parker; F. W. Langner,** Socony-Vacuum Oil Co., Inc., for **E. M. Skinner; D. G. Stevens,** Standard Oil Co. (Ohio) for **F. H. West.**

Added to the Committee on Petroleum Products are: **M. R. Bower,** Standard Oil Co. (Ohio); **M. B. Chittick,** Pure Oil Co. and **H. P. Hobart,** Gulf Oil Corp. **L. C. Burroughs,** Shell Oil Co., Inc., has been substituted for **P. J. Merkus, Jr.**

* * *

J. T. McCoy, Tide Water Associated Oil Co., has been substituted for **L. W. Parsons** on the Subcommittee on Viscosity Standards.

H. G. M. Fischer, Standard Oil Development Co., has been substituted for **A. J. Ely** on the Program Committee.

Arthur E. Pew, Jr., has resigned as chairman of the Committee on Refinery Equipment, and is succeeded by **Walter Samans,** Sun Oil Co. **C. G. Brown,** Shell Oil Co., Inc., has been substituted as a member for **C. C. Wuth,** and he also substitutes for Mr. Wuth on the Subcommittees on Corrosion, Refinery Inspection Supervisors, Unfired Pressure Vessels, and Valves.

L. J. Hallmark, Shell Oil Co., Inc., Houston, has been added to the Committee on Training in Refining.

* * *

Barclay K. Read is assistant sales manager of Western Division of Shell Chemical Corp., with headquarters in San Francisco. He was formerly with R. W. Greeff & Co., also with du Pont's organic chemical department and with Canadian Industries Ltd.

* * *

William C. Skinner, physicist at Magnolia Petroleum Co.'s Dallas research laboratories, is one of two members of Socony-Vacuum's organization to receive its first educational grant. The other fellowship recipient is **Philip D. Caesar,** research chemist at Paulsboro, N. J. The two men were selected from a large group of candidates by a fellowship committee representing the management of the Socony-Vacuum companies.

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Situations Open

JUNIOR ENGINEER: needed for West Texas refinery. Requi e engineering graduate, preferably in Chemical, Petroleum, or Mechanical Engineering. Duties include plant tests, inspection of equipment and assistance on designs and specifications. Will be given opportunity for supervised training in all phases of refinery operations. Prior professional or refine y experience not essential. An opportunity for a practical-minded young engineering graduate. Box 15.

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EDITORIAL COMMENTS

WIDENING HORIZONS

Programs for On-the-Job Training, Like Other Tools, Need Modernizing

ONE important task facing plant operating heads today is the revision of their on-the-job training programs in line with postwar conditions, or setting up organized instruction courses for ambitious plant workers, where there has previously been no such program. The API General Refining Committee has recognized this need by forming a special group to study this subject, survey what the oil companies are doing today, and report their findings back to the industry as soon as practicable. (See pg. 748 for a preliminary report of this committee).

While in many of the larger plants training programs for plant workers were carried on before the war, conditions today make such courses far more important to efficient plant operations. During the war costs were a consideration secondary to volume production and this war-born habit of not being cost conscious has carried over into the postwar period. Figures on the first full year of operation after the war for many companies showed still rising operating and maintenance costs. On-the-job training provides one means for combatting advancing costs.

Processing units of today, in both large and small refineries, are complicated high-cost investments requiring precision control for efficient operation. While in proportion to their output fewer operators are required than with earlier processing units, a higher degree of skill on their part is necessary. All that the crews should know of this new technology in refining, even for a single process, cannot be imparted in the few weeks of instruction the men are given before the unit is started up, by engineers of the licensor of the process or of the contractor, in many instances.

While technological developments in refining were greatly stimulated during the war, resulting in the new processes being installed today, this period of technological improvement is by no means ended. More money is being put into research and development work than heretofore. Technical service departments, or their like under some other name, even in small plants, are prepared to translate the work of the research staffs into plant operating practice. Flexible training programs supply the means to pass on to plant workers the new methods and techniques.

In setting up refining training courses today, plant management has valuable helps that were not generally available before the war. There are located in many industrial centers federally-supported state vocational schools whose facilities can be used to bring the new craft techniques to refinery workers in on-the-job training programs. Help in the selection and instruction of the men who are to conduct the plant programs is available from the same sources. These, and the assistance of the special API study, will help the refineries in setting up practical training programs even though their experience in this field is limited.

The refining companies today are providing modern equipment for the production of the high quality petroleum products in demand. Giving the plant workers the best possible training for the most efficient operation of the equipment is likewise an important tool.

More than Its Own Disclaimer Of Intent Needed to Curb FPC

IT does not seem likely that the natural gasoline and cycling industry, any more than gas producers, will accept at full face value the order the Federal Power Commission issued to itself August 15 that it will not assert jurisdiction over "arm's-length sales of natural gas by Independent producers and gatherers" to an interstate pipeline.

This order is an administrative rule and, like any other made by the FPC and not required by statute, it can be changed at will. In fact, one commissioner dissented from the majority when the order was entered. He contended that exemption of arm's-length sales should come from Congress, rather than that the Commission should itself define its authority over the borderline sales of gas that eventually finds its way into interstate pipelines, and over the previous processing of that gas.

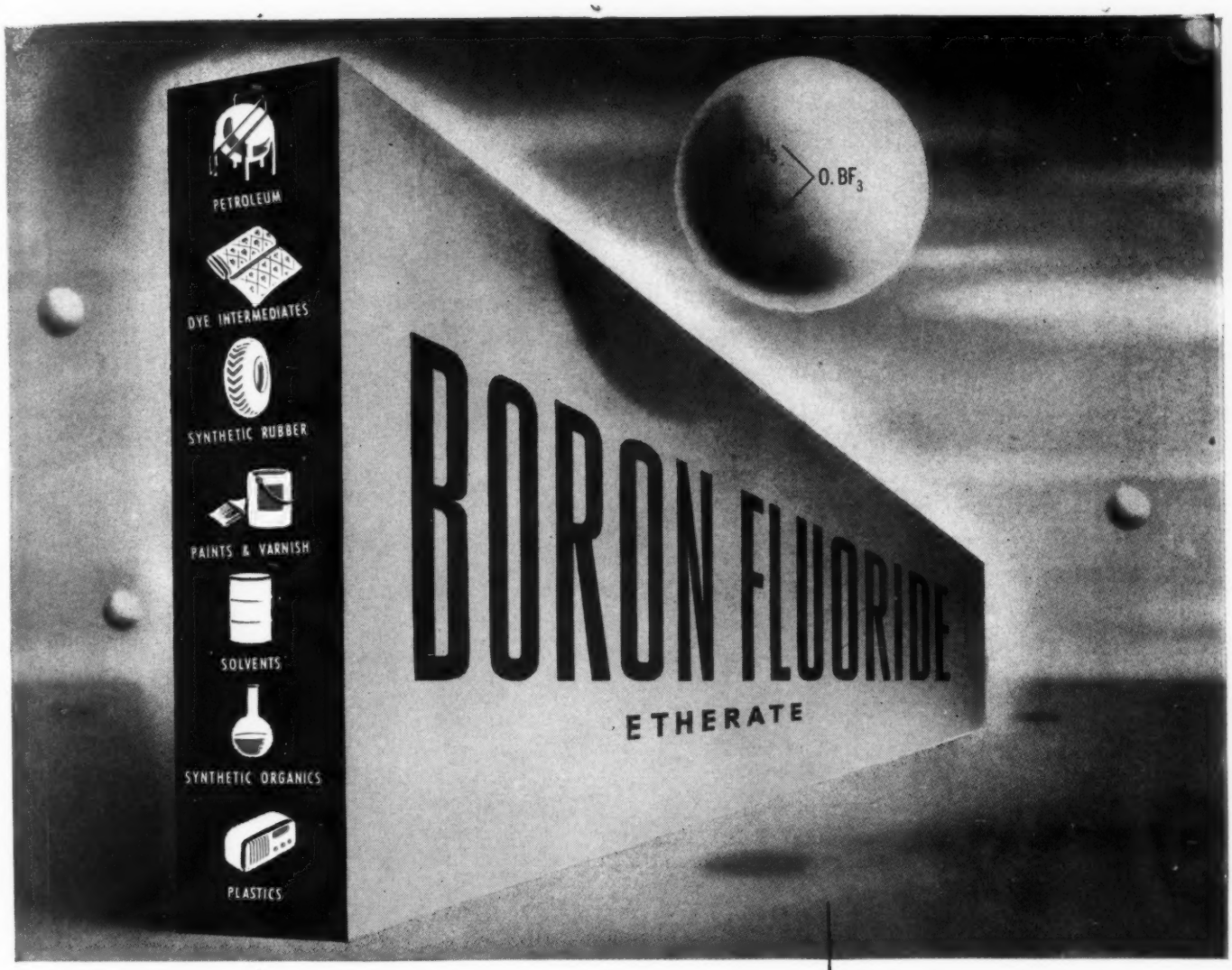
The Commission has repeatedly disclaimed any intent to regulate oil production, or the actual production of gas itself. In fact, until the Supreme Court decision last June in the Interstate Natural Gas Case, the Natural Gas Act of 1938 seemed to clearly state that neither "production" nor "gathering" of natural gas was under the Commission's jurisdiction.

However, at the same time that the earlier FPC disclaimers of intent were being made, cycling and natural gasoline plant operations, as well as local gas producers' operations, were being drawn within FPC's control by virtue of appellate and Supreme Court decisions upholding the Commission's findings. These decisions, particularly in the so-called Cities Service Gas and the Interstate cases, have sufficiently widened the scope of FPC's jurisdiction to permit regulation not only of certain phases of production and gathering of natural gas, but possibly production and gathering of crude oil where associated with natural gas. They have extended FPC authority also to the processing of this gas in cycling or natural gasoline plants, and even to the regulation of the earnings of the gas processing plants.

The directors of the Natural Gasoline Assn. issued a formal statement after the Supreme Court's decision in the Interstate case and before the recent disclaimer of intent, which said in part:

"The Supreme Court decision. . . .may easily be interpreted as a mandate for the Federal Power Commission to regulate and dictate the economics of gas gathering and distribution at natural gasoline and cycling plants, if any portion of that gas is 'destined for' transportation in interstate commerce. In view of previous activities of the Commission, it is only reasonable to assume it will attempt to regulate any purchase or sale of gas, casinghead or plant residue which affects or enters into the ultimate rate charged by a natural gas company for sales of gas in interstate commerce. This authority could extend to regulation of the price paid for natural or casinghead gas previous to processing at natural gasoline or cycling plants, and the exercise of such power would completely disrupt the time-honored methods of gas contracting and sale upon which the building and operation of plants is determined."

The only real safety from the Federal Power Commission's regulatory powers including gas processing plants is for Congress to define the Commission's authority in language that cannot be set aside by legal circumlocution and strained interpretation. Legislation to this end should be presented to Congress when it reconvenes.



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3. As a cyclizing agent for rubber.

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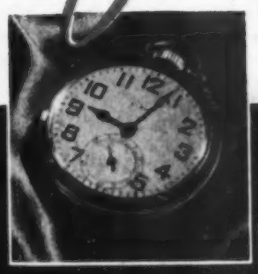

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